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Contents

Page

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Suffolks on a North Essex farm

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AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

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SOIL AND FOOD

PROFESSOR SIR JAMES A. SCOTT WATSON, C.B.E., LL.D.

Chief Scientific and Agricultural Adviser, Ministry of Agriculture and Fisheries

We have the knowledge to combat many of the factors at present limiting agricultural output, and the universal application of that knowledge would do much to close the gap between supply and demand. That is the theme of the Sanderson-Wells Lecture, given by Sir James Scott Watson at the University of London on January 13, 1953, and reprinted below.

IT is being more and more widely recognized that there are grounds for the gravest anxiety about the future food supply of the world's people. The United Nations Organization indeed has said recently that the greatest problem for the next generation will be to produce enough to eat. The main grounds for this concern are three : first, world population is increasing at a rate which, if projected, would imply a doubling and re-doubling of the number of consumers at intervals of less than a century. Second, expansion of food output is currently failing to keep pace with the growth of population, so that the average level of nutrition—inadequate as it has been—is falling. The most recent estimate of F.A.O. is to the effect that, in the past thirteen years, population has increased by 13 per cent, while food production has risen by only 9 per cent. Thirdly, there is a continuing loss of farm land partly through diversion to other uses and (much more largely) by soil erosion—the physical removal of top soil by moving water or by wind.

There are indeed some who predict that while the current rate of population increase—some twenty-two millions a year—may be expected to rise in the immediate future, it will thereafter fall and gradually tail-off, perhaps to zero ; so that sometime in the next century world population may become stabilized at a figure of the order of four thousand millions, or about 70 per cent more than the present figure. But even if such predictions should be fulfilled, immense efforts will be required to prevent widespread famine in the meanwhile.

Food production may be increased, and is being increased, by a variety of means—for instance, by the genetic improvement of food plants and domesticated animals and by the fuller control of plant and animal diseases, insects and other pests. But probably the greatest contribution towards the solution of the problem can come from the fuller and more efficient use of the world's soils.

My present purpose is to consider firstly how far our existing knowledge can take us towards this last objective, and what gaps in our knowledge

remain to be filled; and, secondly, and only briefly, how the sum of knowledge is to be brought to bear more fully and more speedily in the fields of hundreds of millions of cultivators.

Search for the Essence of Fertility It is not to be wondered that from very early times men and women have pondered, speculated and argued about the principles of plant nutrition and soil fertility. Many of the phenomena of plant growth were supposed by the ancients to be under supernatural influences: the earth goddess played a large role in the mythology of the early cultivators. The Roman writers already knew that certain crops, such as wheat, exhaust the goodness of the soil, while others—notably the legumes—enrich it. The major explanation of these facts was found only in 1888. The early authors of Western Europe groped for what was, as we now know, a greatly oversimplified explanation of the facts—they sought a single "principle of vegetation". Van Helmont deduced, from his famous pot experiment with a willow tree, that water was the sole plant nutrient. Later, Glauber suggested that saltpetre was "the principle," having indeed shown that animal urine generated nitre and also that plants showed astonishing responses to very small amounts of this salt. Thaer, in his well-known *Principles of Agriculture*, published early in the last century, adopted the then prevalent view that plants drew their nutrients exclusively from humus. "The fertility of the soil," he says, "derives essentially and wholly from humus. It is humus alone—apart of course from water—that provides the plant's nourishment. Humus is at once the product and the essential basis of life."

In more recent times practical farmers in various parts of the world came to regard one particular substance as constituting the essence of fertility. The dairy farmers of Cheshire a century ago pinned their faith to animal bones—and rightly, for their soils had become grossly deficient in phosphate. Farmers in some parts of New England came to regard gypsum as the key to crop production, and large quantities were imported from France: presumably their soils were deficient in sulphur. Again, it is interesting to speculate whether, if Australia had been settled by a cultivator people a few thousand years earlier than it was, a chance observation would have led to the identification, as the principle of vegetation, of some particular ore that happened to contain traces of zinc, copper and molybdenum.

About a hundred years ago, at Rothamsted, a notable advance was made by the identification of what are now called the "major" plant nutrients. The Rothamsted soil, it appeared, provided sufficient of all but three of the essential nutrients. Broadly speaking, all crops responded significantly to compounds of potassium, phosphorus and nitrogen, provided only that the forms used were in some degree soluble in the soil water. There was indeed the anomaly that the legumes, while they responded to nitrogen when grown in sterilized soil, failed to do so in the field; the explanation was found only a quarter of a century later. Still later, further exceptions were found to occur in other groups of plants—the heaths and certain trees—in which another form of symbiosis is normal, so that the plants in question do not depend entirely on the soil solution.

It was a fortunate accident that the Rothamsted findings should have applied very widely. It was only in the new countries that large areas of land were found in which gross deficiencies of other essential nutrients occurred. There was, however, an understandable temptation to suppose that the Rothamsted findings constituted a complete answer to the old problem. The old prescription had been lime, drainage and dung; the new one

seemed to suggest that nitrogen, phosphate and potash constituted a complete substitute for dung.

We do not know how many farmers made a complete break with tradition and attempted to farm " on the manure bag," i.e., without animal dung or other organic manure. Some who did so met with unexpected difficulties. There is, however, the interesting case of John Prout who, after a long experience of clay-farming at Sawbridgeworth in Hertfordshire, remained convinced that the Rothamsted work did justify the complete break with tradition. " The bulk of my cropping," he wrote, " is grain, and I have no intention of replacing any portion of it by forage or root crops for livestock . . . I sell both the corn and straw, and, after nineteen years' experience, I see no reason for abandoning my practice."

We now know that, on perhaps nine farms out of ten, Prout's system would have broken down through a build-up of the soil-borne diseases of wheat ; and we may suppose that if he had attempted to grow potatoes, onions or lettuce, he would have found increasing difficulty in securing suitable tilths. Fortunately, though he published a very plausible argument for his system, and advocated its widespread adoption, he found few disciples. A majority of farmers maintained a strong belief in the efficacy of animal manure.

Our Knowledge about Nutrients Subsequent research has greatly extended the list of nutrients that the plant must obtain from the soil. They are conveniently placed in four groups. First, are the Rothamsted trio, which are required in substantial amounts and which many soils fail to provide in available form and in optimum amounts. Secondly, are three others which are also needed in substantial quantities but with respect to which most soils provide adequate amounts to most plants—sulphur, calcium and magnesium. Thirdly, are the half-dozen essential elements—manganese, iron, boron, copper, zinc and molybdenum—of which the plant's requirements are minute. Fourthly, are sodium, silicon, aluminium and perhaps nickel, which are "beneficial" to certain crop species. The probability is that the list is now complete.

The adequacy of our knowledge can be tested experimentally. We may start with water, distilled with every precaution against contamination, add highly purified soluble compounds of the essential elements, keep the solution oxygenated, and grow in it successive generations of plants. Apparently normal growth can be secured by such procedure, and there is no evidence, so far as I am aware, to suggest that the nutritive qualities of the plant material are in any way deficient or abnormal. Commercial water culture—"hydroponic" cultivation—has practical advantages in certain circumstances. It obviates risk of soil-borne diseases in the plants grown, and also of a rather obscure condition known as " soil sickness," which can be troublesome under glasshouse conditions.

Perhaps it is necessary at this point to mention the opinion sometimes advanced to the effect that the particular source of plant nutrients is important—for example, that nutrients derived from organic matter, by biological activity, are of higher value than such as are produced by synthetic or other "chemical" processes. The fact is that the higher plants (except those that live by symbiosis) absorb their nutrients in the form of ions ; and the sulphate or the ammonium ion, for example, is the same thing whether it is derived from a biological or an industrial process.

The Soil as a Reservoir Some of the early writers regarded the soil simply as a reservoir of plant nutrients ; and indeed it is part of our proverbial wisdom that the farmer must give back to his land what he takes out of it. But the reservoir conception is a serious over-simplification. For one thing, the reservoir is a leaky one. Nitrogen, as nitrate, is readily washed out of the soil and into the drainage water. Nitrate, too, is liable—under waterlogged conditions—to be destroyed by anaerobic organisms, with the evolution of free nitrogen. This circumstance appears to explain the fact that rice, grown under swamp conditions, gives a much better response to ammonium salts than to nitrate. But one way or another, a proportion—often substantial—of applied nitrogen is lost, the amount depending on rainfall, drainage and the structure of the soil.

Again, in most soils a substantial proportion of the phosphate that we apply is virtually lost, not by leaching but by fixation in forms that are not available to plants. Many experiments in this country have given figures of the order of a third as the proportion of a particular application recovered during the period of an ordinary rotation. In one of our classical long-term experiments at Cockle Park in Northumberland, the proportion recovered over more than half a century is of the order of 10 per cent. The reactions involved appear to be complex, partly biological, partly simple combination with compounds of iron and aluminium, and partly absorption in the clay lattice. Potash fixation is a much rarer problem, but it has been a major difficulty in the farming of some of our own chalk lands. Fixation of trace elements can also occur. Indeed, the commonest cases of manganese–and–boron–deficiency in crops occur after heavy applications of lime.

In the years following the classical Rothamsted work, it appeared to many that fertilizer usage could be prescribed on the evidence of soil and plant analysis. If one knew the needs of a particular plant species, and if one determined the soil's content of the various nutrients, it should be possible to apply those amounts of the various nutrients that would produce optimum yields. But it was not to be so easy. Not only did the various crop species show varying capacities to extract nutrients from a given soil, but "complete" analysis failed to distinguish between what was available and what was not. Some progress has now been made in the development of methods for determining "available" nutrients—mainly by the use, as extractives, of dilute solutions of weak acids. But it remains true that the laboratory figures require to be interpreted for the particular soil type and the particular crop, and much more remains to be done in correlating laboratory results with crop responses on various types of soil. Only after this will the soil chemist be able to make firm recommendations with full confidence.

Importance of a good Soil Structure Thus far we have considered the soil as a source of nutrients. But it has long been recognized that fertility depends also on its physical make-up or structure. Gravels are burning or "hot," sands "hungry," clays are "cold," "late" and "stubborn". Some old fen soils are "dead". Loams are, in general, fertile. Depth has long been recognized as of great importance.

It has proved to be a highly fruitful approach to scientific problems in general to seek the simplest among the various possible explanations of a group of natural phenomena ; and it seems that there is, in fact, a simple hypothesis that largely accounts for the relation between soil structure and plant growth. Firstly, plants require, for full growth, a tolerably constant

supply of soil moisture ; and secondly, root activity, and therefore growth, depends on a constant supply of fresh air throughout the root zone. Incidentally, it would appear that it is an excessive concentration of carbon dioxide in the soil air (rather than a low concentration of oxygen) which impedes root activity. The extreme CO_2 content appears to be about one per cent.

The aim of the cultivator is therefore to produce a structural condition which will permit aeration and yet enable the soil to retain, against the force of gravity, a substantial amount of water—a structure comparable to that of a loosely packed mass of small sponges. The farmer, in endeavouring to produce such a structure, is helped by alternate frost and thaw, and by alternate wetting and drying. But the ease or difficulty of producing the desired condition depends on the nature of the binding agents. These (in the soils of temperate regions) include, firstly, living organisms—the finer plant roots, living fungi and actinomycetes, or their dead tissues ; secondly, colloidal clay ; and thirdly, the rather unstable colloidal compounds produced in the process of decomposition of organic matter. The clay colloids by themselves are, in general, as every farmer knows, too strong, imparting to the soil a sticky, plastic texture when completely wetted and, on drying, yielding hard, impervious clods. Clays, too, shrink on drying and open wide cracks during periods of drought ; hence rain, when it comes, runs down to the lower zones without wetting the intervening blocks. Silty soils, on drying after rain, tend to form continuous surface crusts, so that soil ventilation is impeded. Again, not all forms of organic matter promote good structure. Some of our black fen soils, which are almost wholly composed of organic remains, dry down to a sooty powder, and are therefore very subject to wind erosion.

It is possible, by blending natural materials, to produce something approaching the ideal soil, with an optimum and relatively stable structure. This is done by the gardener in the preparation of seedling and potting composts. The common ingredients are sand, certain particular forms of peat, and the decayed grass turf grown upon a fertile heavy loam. The resultant material absorbs water readily, drains freely, keeps well aerated, and yet holds a goodly stock of moisture within its crumbs. It does not puddle when wetted and retains its structure well on redrying.

The traditional method of maintaining satisfactory soil structure—apart from well-chosen and well-timed tillage operations—is the periodical admixture of fresh or partially rotted organic matter—farmyard manure, leaf-mould, compost, green manure or, in some areas, a living grassy sward. Certain organic materials have well-known disadvantages—for instance, cereal straw, in the process of decomposition, uses up the soil's stock of available nitrogen compounds, so that the immediately following crop may suffer from nitrogen starvation.

It would obviously be very valuable if a collodial substance, more stable than that produced from decaying organic matter, could be found. And current research points to the possible value, as " soil conditioners," of certain synthetic plastics.

A third group of problems is presented by the soil-borne diseases and parasites—by fungoid diseases such as clover rot, club root of crucifers, and "take-all" of wheat ; and by parasites such as the eelworms of the potato, sugar beet and cereals. There is, too, the related problem of weed control. But these problems are outside the range of my present subject.

Soil Erosion presents no Insuperable Problems

Let us now look, in turn, at some of the farmer's problems. Erosion is, of course, a natural phenomenon. Rocks have been worn away, and the eroded material laid down as alluvium, loess and glacial drift throughout geological time. Even from the farmer's point of view, a measure of erosion may be desirable. Very ancient soils, like those of level tropical areas, have been so heavily leached through the ages that they have been largely depleted of their original reserves of plant nutrients. They would have been better had they been continuously refreshed by newly weathered rock flour, with the removal of the older material. But if soil erosion proceeds faster than soil formation, then the productivity of the land must progressively decline. This excessive erosion is no new phenomenon—it goes back to the early days of cultivation. But partly because of increasing pressure of human population on soil resources, and partly through ignorance or a want of social conscience, it has recently assumed alarming proportions.

Control of water erosion—soil washing—is partly a matter of land-use planning. The *erodability* of a given piece of land is measurable, depending on its slope, on the amount and seasonal distribution of rainfall and the predominant type of rain— drizzle or downpour—and also on the structural characteristics of the soil itself. The most highly erodable areas must be kept under forest ; the next category may be used as pasture, with due precautions against overgrazing. The next again may be cultivated, with some combination of precautions—broad-base terracing; contour cultivation ; the use of cover-crops to protect the surface against the impact of raindrops ; measures to improve and preserve crumb structure, to the end of ensuring that rain will run into the soil rather than run off ; and the use of fertilizers to ensure rapid and full coverage of the ground, and to give an abundance of organic residues to be ploughed in.

Control of wind erosion is again partly a matter of land-use planning. Land that is highly susceptible to blowing must be left under perennial plant cover. Windbreaks of trees are less effective than many have suggested, even tall trees providing protection only of a narrow belt on the lee side. The preservation of crumb structure is of course important, since sizable particles are highly stable. But the most effective control, where it is practicable, is what is called "trash" farming—the abandonment of the mouldboard plough (which buries stubble and other vegetation) in favour of a disc implement that leaves behind it lines of firmly anchored but unburied plant material.

Soil erosion thus presents no insuperable technical problems. The main reasons for its continuance are lack of knowledge, pressure of population, and the overgrazing of pastures, which in many areas results from the traditional assessment, by stock-keeping peoples, of a man's social prestige by the size of his flocks and herds.

It is worth mention that the loss of top soil by erosion is not quite so disastrous as, twenty years ago, it was generally supposed to be. It is true that if an area is cut into small pieces by deep gullies, crop production on the remaining area is apt to become quite uneconomic. But in cases of "sheet" erosion what was originally subsoil can be brought back to a very fair level of productivity in a reasonable time. Promising results in the way of making soil out of subsoil are being obtained in our own country on former ironstone workings, where the position is essentially the same as on sheet-eroded land, the former topsoil having been deeply buried. Moreover, gully formation, where the process has not gone far, can be reversed by the construction of dams to catch silt.

To pass on, many soils, in their natural condition, are of little value for food production. For instance our own podzols, in their natural state, are capable of producing few crops of much value—coniferous trees, heather, gorse and heath grasses. The typical podzol must be fundamentally changed; firstly, by liming—for it is naturally very acid—and by applications of mineral nutrients, including especially phosphate. So it is in many other cases. But whether or not the land has been under cultivation, there is usually some cause limiting crop growth which can be removed. The limiting factor may be any one of many, and hence any one of a variety of measures may have to be applied.

Water—the Limiting Factor Over a large part of the world the limiting factor is water, and there are a variety of measures that may be applied. One that is obvious is the selection of crop plants with low water requirements—wheat, for example. Another is the production, by breeding, of drought-resistant varieties. Another is so to adjust sowing dates that the crop will be harvested before the dry season. In our own East Anglia the earlier sowing made possible by the mechanization of tillage would seem to have had a marked effect on yields of sugar beet and barley. This idea is carried much farther in the winter-wheat belt of the United States, where the types of wheat grown, sown in October, come to harvest in early June and cease by about the end of April to make any considerable demands on the soil moisture.

The other approach is, of course, by irrigation. There is, up and down the world, a great deal of land that could be irrigated with great profit, the difficulty being to find adequate supplies of water of suitable quality. Even in our own country there is an area around the Thames estuary where irrigation would result, in nine years out of ten, in substantially increased yields from most crops ; and perhaps half of England would respond similarly in five years out of ten.

In all irrigation works scientific water control is essential to continuing success. A sadly common story is of a few years of bountiful crops followed by a period in which an increasing proportion of the land is sterilized by the accumulation of salt. The principles of water control are simple. Overwatering must be avoided during the period of maximum evaporation, and the land must be periodically flushed with excess water in order to carry away in the drainage the excess of salt.

As already said, the capacity of the soil to store water, between wet seasons, depends upon the crumb structure that a good farmer manages to secure through the maintenance of the humus content and the use of appropriate methods of tillage. The use of mulching, with straw or other protective material, is useful with widely-spaced crops, partly perhaps by preventing evaporation, but more importantly by preventing the rise of soil temperature to a level that would reduce root activity.

Mineral Nutrients Certain natural soils are extremely unproductive by reason of gross deficiency in some essential nutrient. As already said, large tracts of worthless Australian bush have been transformed into useful land by the application of missing trace elements, in quantities of the order of ounces—or even fractions of an ounce—per acre. Again, traditional systems of farming have sometimes depleted the soil of some essential nutrient—the long-continued cheese-farming, in Cheshire, left the soil grossly deficient in phosphate, and phenomenal improvement

was achieved by the use of bones—incidentally going back to a time before the chemist had discovered the role of phosphate in plant nutrition. In my own home district the story of the outstanding effect on the growth of red clover of Stassfurt potash salts, when these were first used in the 'seventies of last century, has become part of local farming tradition.

It has occasionally happened that particular nutrients have been applied, over periods of years, in excessive amounts and with harmful effects. In parts of Jersey, for instance, where highly intensive cultivation with heavy manuring has been practised over a long period, troubles are arising because the soil content of available potash or phosphate, or both, is five, ten, or occasionally fifty, times as high as any plant requires.

Nitrogen : Natural and Synthetic It has already been said that the ancients were aware of the curious circumstance that legumes, instead of exhausting the soil, appeared to enrich it ; and again, that well before there was any scientific understanding of plant nutrition, the potency of saltpetre as a fertilizer had been noted. Later on, but still before nitrogen was recognized as an essential nutrient, guano and Chilean nitrate were imported in large quantities into this country. More than fifty years ago Sir William Crookes, in his address to the British Association, pointed to the rapid exhaustion of known resources of nitrogen compounds, and logically argued that, failing some method of producing nitrogen compounds from the air, crop yields must decline and a food crisis must result.

Today the farmer has a choice between two main sources of nitrogen, in quantity adequate for the needs of his crop and making allowance for the inevitably very heavy wastage. The one is to introduce legumes into his rotation, the other is to use nitrogen salts, now very largely produced synthetically.

It should be noted that there is a wide range in the efficiency in nitrogen fixation of the various legumes. In general, the herbage species, clovers, lucerne, etc., are highly productive, while pulses, including soya beans, earthnuts, etc., are relatively ineffective. Under certain systems of agriculture—for instance, grassland dairying in New Zealand—a high level of production can be maintained on legume-fixed nitrogen alone. Under our own conditions the clovers can provide the grasses with all that they require during only part of the growing season—the probable explanation being that grass can grow, early and late, at soil temperatures which are too low for nitrification to occur. Regarded as a manure for arable crops, a ploughed-in clover sward tends to decay faster than the farmer would wish, yielding an overdose of available nitrogen in the first season and too little in subsequent years. Farm production, even at its present level—and much less at the higher level which will be required—cannot be supported without resort to "artificial" nitrogen compounds.

I know that it is maintained by some that we should have less plant disease if we employed more "natural" methods of maintaining fertility. It would, indeed, be true that if we reverted to a primitive system of husbandry, planting a variety of species in admixture, we should escape serious loss from certain particular diseases of plants—just because we should be keeping nearer to the balance of nature. But such systems are incompatible with mechanized cultivation, and a return to them would be followed by a disastrous fall in the productivity of farm labour. Clover rot and club root assumed serious importance long before the era of artificial fertilizers, just

because a four-course rotation—as a substitute for the balance of nature—was too short ; the fungi survived the interval between successive sowings of its host plant. In the case of many soil-borne diseases, there is no practical prevention except an appropriate rotation, the intervals between successive crops of a given crop being based on the capacity for survival of the parasite.

Knowledge Must be Applied As it seems to me, while there are still gaps to be filled, our existing knowledge of the soil would suffice, if it could be fully applied, to enable a very large increase in the quantity of food production and without sacrifice in nutritive quality. The main difficulty is to get that knowledge applied. Let me take one example. Rice, which is the staff of life of a very large fraction of the human race, is, in its proper environment, a more productive crop than wheat in its proper environment. The yield of wheat approaches 30 cwt. per acre in Holland, and is now well over 20 in Britain. But the yield of rice per acre in the main rice-eating countries is less than 8 cwt. It could thus be raised threefold, if the known methods of plant improvement were applied, if resources in the way of fertilizers were made available, and if appropriate methods of tillage and water control could be applied. But each environment requires its own varieties, its own fertilizer prescription and its own cultural technique, and the vast majority of rice-growers are illiterate, and their only guide is age-old tradition.

The problem is one of a great number that the Food and Agriculture Organization is attempting to solve, and progress can be recorded. As examples I may mention the international scheme for the control of desert locust ; the plan to reduce and perhaps eliminate rinderpest by vaccination ; the production of new and better varieties of rice ; the dissemination of knowledge about soil fertility ; and assistance in the procurement of essential materials and tools. It is, as I think, of profound importance for the future well-being of the world that the more advanced countries should give continued and increasing help, both in men and money, to this Organization. Only through the methods that it now employs—helping people to help themselves—can progress in material well-being become universal. And I believe that material well-being is a prerequisite to progress in civilization as a whole.

Warble Flies

Considerable losses of milk and meat and damage to the hides of cattle are caused by warble flies every year. The Warble Fly (Dressing of Cattle) Order, 1948, requires all cattle visibly infested with the maggots of warble fly to be treated with a derris dressing as soon after March 15 as the maggots are seen under the skin of the cattle. The dressings must be repeated at monthly intervals for so long as the maggots continue to appear under the skin, or until June 30, whichever is the earlier.

RESEARCH FOR PLENTY

No. 6. NATURE'S CATTLE

ALLAN FRASER, B.Sc., M.D.
University of Aberdeen

PASTORALISM is a difficult word to say and one none too easy to define. It includes ranching, but is a term wider than ranching. It embraces the nomadic way of life such as the Bedouin live in North Africa or the Lapps in Scandinavia. It is concerned with animals of one kind or another and of their husbandry under almost natural conditions. It includes what we call hill farming in this country, although, in fact, pastoralism is something very different and, in certain respects, opposed to farming.

In newly-developed countries, pastoralism precedes cultivation. It was so in the Americas, in Australia, and in South Africa. Particularly during the course of the last century there was a great surge—a mass migration as it were—of the domesticated animals of the Old World on to the virgin pastures of the New. The wool-bearing Spanish-Merino sheep colonized Australia ; the three great breeds of British beef cattle—Shorthorn, Hereford, Aberdeen-Angus—spread over the fertile, uncultivated plains of both American continents.

In new countries, pastoralism is profitable because the grazing animal—it may be cattle or it may be sheep—has ready and cheap access to the best natural pastures on the best land. But as the human population becomes more dense and as the better land becomes cultivated and divided up into holdings, the area available for pastoralism becomes restricted. There is less land available for ranching, and that land is the poorer land. In older countries it comes about, therefore, that pastoralism begins where farming ends.

Now, in any real effort to increase the world's food supplies, farmed land must be expanded to the maximum, and pastoral land correspondingly reduced. For it is undeniable that land under cultivation produces more food. Agriculturists are agreed, however, that not all of the world's limited land surface is amenable to cultivation. Much land, suited only for pastoral production, will remain. It is one purpose of this article—indeed, its main purpose, to discuss and to suggest how and in what ways pastoral production can be increased, so that pastoral land may come to contribute a far greater quantity of animal produce to the world's larder than it does today. It is convenient to discuss this problem under three main headings : as it affects the actual grazing ; as it affects the grazing animal ; and, finally, as it affects the biological relationship between these two.

Pastoral Land can be Improved First then, for the grazing. Because pastoral land is not amenable to cultivation and the sowing of nominated crops, we may imagine that the productive capacity of pastoral lands cannot be increased by any other means. There could be no greater error. Methods of doing so are implicit in much research work already completed. There are further and wider possibilities in the research work in progress today and in that planned for tomorrow.

There was a time, and that not so very long ago, when grass, even on fertile and well-cultivated land, was just grass and nothing more than grass. The work of the pioneers—Gilchrist at Cockle Park, Elliot at Clifton Park,

and above all, that of Stapledon and his disciples at Aberystwyth—has changed all that. The work that started on the cultivated grasslands of England and Wales must be extended to the pastoral areas of the whole world.

It is certain that natural pastures *can* be improved. It is exceedingly doubtful, however, whether in the recent past attempts at improvement have always been carried out in the most prophetic way. Cahn Hill was a great experiment, a noble enterprise, but demonstrated little more than this—that with great effort and considerable expense, the hem of the hills' skirts can be slightly lifted for the grass species appropriate to lowland cultivation to creep a little way underneath. Yet, on the hills themselves, in the deserts, in the sub-arctic tundras, in all the wild places of the earth, there are innumerable species of grasses and of other herbage plants which, if studied, selected and improved, might serve to clothe the entire wilderness in a new dress.

Again, the aeroplane, in its conquest of altitude and distance, has opened up new possibilities in the bringing of fertility into lonely places. The accuracy of placement made possible by the helicopter has been added to the wide range of country an aeroplane can cover. More carefully planned application may remove the necessity for a heavy manurial load that at the moment constitutes the limiting economic factor for using the aeroplane in manure distribution.

Nevertheless, despite these possibilities of future development, pastoral land will remain pastoral land, lacking the capacity for revolutionary alterations in cropping and productivity possessed by inherently fertile and intensively farmed land. The wilderness will remain the wilderness, however freely it may be made to blossom.

Exploiting Environment Now, in all successful pastoral husbandry, the essential factor is the closest possible adaptation of the grazing animal to the natural pasture. In seeking the most suitable animal to convert the trapped sunlight of the wild herb into human food, we have perhaps been a trifle conventional in our outlook.

Domesticated or semi-domesticated animals of one species or another have always been the harvesters of the sun's energy falling on the vast acreage of pastoral lands. Such animals today are usually cattle or sheep, but they may be goats or camels, or reindeer, llamas, vicunas or yaks. Very possibly, it is due mainly to the fact that the pastoral regions of the Southern Hemisphere were first colonized by European nations that these lands carry stock mainly derived from European breeds of cattle and sheep. Had the Incas of South America achieved a world empire we might today have found llamas in Northumberland and vicunas on the Grampian Hills. It has so happened, however, that cattle and sheep, either separately or together, form the predominant livestock on pastoral country throughout the world. It is possible, indeed probable, that these two species, of proved superiority under conditions of adequate rainfall and temperate climate, may have been pressed to the full limits of their capacity for adaptation and, in some cases, beyond it. It may well prove that, given a wider range of animal species, the extent of the world's pastoral enterprise can be substantially extended.

It would seem that the leaders of animal husbandry development throughout the world are beginning already to both think and act along such novel lines. First, and somewhat tardily, has come the realization that much of the apparent productive superiority of European breeds of livestock is a partial result of the productive superiority of European land, climate and

farming methods, and is in no case entirely inherent in the stock themselves. At one time—and that not so very long ago—the term " livestock improvement " in undeveloped countries was practically synonomous with the introduction of breeds of European origin, or of progressive upgrading of native stocks of horses, cattle and sheep to European standards. Such means of livestock improvement proved eminently successful where conditions of soil, climate and husbandry were not too far removed from those of countries in which the improved breeds had their origin. They have failed in the past and may fail again in the future wherever environmental conditions differ fundamentally from those in which European breeds of livestock were first evolved.

A more modern method is to base livestock improvement in undeveloped countries upon species and breeds originating in, or long native to, such countries. In this connection the investigation of Dr. Norman Wright upon native breeds of Indian cattle proved of fundamental importance. He concluded that given improved husbandry conditions and some selection, the milking capacity of such native breeds, long thought negligible, could approach the standards accepted as normal in the dairy breeds of European cattle. Recent investigations on native cattle in South Africa have confirmed this finding. In general, it would appear that the low production of many breeds of native livestock is due to limiting factors, mainly nutritional, in their environment, and is not in any way attributable to an inherently low productive capacity conditioned by their genetic constitution.

Apart altogether from questions of productive capacity, native breeds of undeveloped pastoral country often have the substantial advantage of climatic adaptation and a relative immunity to endemic disease. This has led to the conception of grafting, as it were, the superior productivity of breeds of European origin upon the climatic-and disease-resistant native livestock. Examples are the crossing of European upon Zebu cattle in tropical countries, or upon American buffalo in sub-arctic countries, or the crossing of European sheep upon the native fat-tailed sheep of the African Karroo.

Tradition of Seasonal Migration The right species, breed, variety to suit the soil, the climate, the vegetation of a country—that is the basis of success in pastoral husbandry—that, and the stage management to fit the play and cast. The pastoral nomad, for example, begins by driving the species of grazing animals on which he subsists—the actual species may be cattle or sheep, or camels, reindeer or goats—from place to place according to the season. Thus in Arabia the nomad Bedouin tribesman who has exploited the summer grazing of Jordan with his stock, migrates in winter southwards into Saudi Arabia. He pays small attention to the boundaries drawn on a map he has never seen, based on political divisions he does not recognize.

Similar considerations govern the reindeer husbandry of the nomad Lapps. Mikel Utsi, now in charge of the experimental reintroduction of reindeer into the Scottish Highlands, has described that husbandry. In the journal called *Man* in 1948, he wrote :

> Until I was fifteen my family lived in the northernmost parish of Sweden. A considerable part of the sparse population consisted of reindeer-owning Lapps, who migrated with their herds over the watershed to the Norwegian coast in the summer, and back again and down into the forests in the winter.

A similar method of semi-nomadic husbandry prevailed in the hill country of Britain until relatively recent times. It is usually referred to as the

" shieling system " in the Scottish Highlands. The general policy of the shieling system can be summarized in a sentence. It was a system by which all livestock were summered among the hills while the valleys were devoted to growing grain for people and forage—mainly hay—to support the livestock in winter. It was a system which endured, almost unchanged, for over a thousand years.

No very lengthy journey was involved in the shieling migration. Far longer migrations characterized another system of pastoral husbandry—the Merino sheep industry of ancient Spain. Flocks of many thousand sheep were in the hands of a few rich owners, the nobility, the clergy, the King. These flocks were wintered in the plains and valleys. In spring they were driven over distances of up to 500 miles to summer pasturage in the mountains, where they were shorn, returning by broad sheep tracks to the lowlands when winter came. A system, similar in principle and based on the same breed of sheep, has been adapted to the sheep range husbandry of the American Rocky Mountains.

Now in all those systems of pastoral husbandry so far outlined, there is an implicit recognition of the most important biological factor governing this form of animal production. In the first place the animals were not kept continually and throughout the year upon the same area of ground. Seasonal migration is an essential element in the primitive pastoral life. It is the reply of the primitive pastoralist to the question posed by the seasonality of plant growth.

Overcoming the Problem of Seasonality Such seasonality of plant growth is, in fact, *the* limiting factor in the productivity of pastoral husbandry. Seasonality may be governed by rainfall or by cold. In either case it leads to a pause in plant growth at some time of the year. Unless this seasonality is actively combated, the carrying capacity and, in consequence, the food-producing capacity, of pastoral country will be limited by the number of stock the lowest level of plant growth can support. That level is quite often a mere fraction of what plant growth is capable of providing at more favourable seasons.

Methods of combating seasonality may be designed both from the angle of the animal and from that of the plant. In pastoral areas where drought is the seasonal limiting factor in production, species of animal that can best survive drought are the species of choice. Sheep require less water than do cattle and that is why sheep, as contrasted with cattle, penetrate farther into regions of low and uncertain rainfall. Animals such as the camel and the fat-tailed sheep that store fat easily and in quantity, have an important advantage.

In pastoral areas sub-arctic in climate because of latitude or altitude, species of animal most resistant to cold and to the seasonal food shortage resulting from cold, are the species of choice. Here, the cattalo, the cross between American bison and Hereford cattle, may have a part to play, since the cattalo will ride the rigours of an Arctic storm where European cattle will flee before it to their death. Both reindeer and sheep have this further advantage over cattle. They will scrape down through snow to reach the covered vegetation while cattle, at least those of European origin, lack the instinct to do so. In finding the right species, breed or variety of animal, therefore, there lies one important method of widening the bottleneck in production imposed by seasonality of plant growth.

Conservation, whether of food, of water, or of both, is the second important consideration. Desert shrubs, that by their natural yet protected succulence will hold water deeply buried in their edible leaves or stems ; hill plants that, growing in spring season, will tinge the edge of the melting snow with early green ; summer grasses that, standing throughout drought or winter, provide a natural hay—these are all the methods of conservation native to the pastoral lands themselves. Such conservation implies management, and the essence of pastoral management is regulation of grazing. Without such regulation, where grazing is continuous throughout the year and uncontrolled, the stock-carrying capacity of any pasture will deteriorate inevitably, as Martin Jones first showed in England.

The old answer to such deterioration was migration of stock. The modern alternative is *fencing* and, indeed, without fencing there can today be no proper management of pastoral land. Fencing that allows the resting or "spelling" of over-stocked land, and the heavier stocking of under-grazed land, that permits conservation of fodder for seasonal shortages on pastoral land, may prove an adequate substitute for the nomads' seasonal migrations.

In addition, it may become necessary to dedicate, as it were, a limited area of cultivated farmland adjacent to all pastoral regions, for the special and avowed purpose of providing forage to bridge over the seasonal gap. The area required for this purpose would not be impracticably large. For example, I have calculated elsewhere that were no more than one-sixth of the acreage of hay grown annually in Scotland devoted to this special purpose, it would serve to provide the essential winter supplement for over half a million breeding cattle on the Scottish hills.

INCREASED PRODUCTION OF BEEF IN THE UNITED KINGDOM

V. H. Beynon, B.Sc.(Agric.Econ.)
Department of Economics, University of Bristol

British farmers now supply nearly four-fifths of our beef and veal. But there is still an urgent need for greater production. This, the writer suggests, can be easily and profitably achieved on many farms by introducing beef production as a subsidiary to the main farming system, depending for feed on home-grown feedingstuffs and by-products of the farm.

CONSIDERABLE dietary changes were forced upon the population of this country soon after the outbreak of the war, and some of these changes have persisted until recently. But there are signs now of a return to the more nutritious foods which featured prominently in our pre-war diet. For instance, food consumption levels now show that milk and eggs are being consumed in even greater quantities than before the war. The people of this country, however, are still acutely aware of shortages. Of course, the lower income groups undoubtedly experienced shortages before the war, and there were wide variations in the food consumption levels of

the different income groups. But the variations are not as great at the present moment—rationing and various welfare schemes, as well as subsidies, have brought about a more equitable distribution of our limited food supplies. In addition, the levelling out of incomes has had a significant effect, and it seems that at present prices most families can now afford a whole range of foods previously considered too expensive and purchased by the higher income groups only.

Meat rationing is causing considerable anxiety to the housewife, for the supplies are considerably below pre-war levels. The data set out in Table 1 show that before the war the average quantity of meat eaten per head was 129 lb., but variations in this average amounted to as much as 100 per cent. For 1951, the average was 88 lb., but the variations between income groups had narrowed considerably and it can be assumed that the nation as a whole was better fed than before the war. As regards beef and veal, consumption averaged nearly 55 lb. pre-war and only 33 lb. in 1951. Indeed, our beef and veal supplies have dwindled alarmingly, the reduction in the main being due to the virtual disappearance of our overseas supplies, and in particular to the drastically reduced quantities bought from the Argentine. Whereas in 1938 Argentina supplied us with 354.3 thousand tons of beef and veal, by 1951 the amount was 48.1 thousand tons, and we have not been particularly successful in replacing these supplies from elsewhere. The efforts of our farmers have gone a long way towards helping out, and annual production in 1951 exceeded that of 1938 by 47 thousand tons. Put in another way, before the war about half of our total beef and veal supplies were home-produced, compared with nearly four-fifths at the present time. It seems very unlikely that imported supplies will increase significantly in the near future. A rising standard of living in the exporting countries and a tendency towards greater industrialization, together with balance of payments difficulties in Great Britain, are potent reasons why a return to pre-war conditions is unlikely. The task before the United Kingdom then is one of increased production at home. Is this possible ?

Table 1

United Kingdom Meat Supplies

(including offals and tinned meat, but excluding game and poultry)

	1938		1947		1951	
	000 tons	*per cent*	*000 tons*	*per cent*	*000 tons*	*per cent*
Beef and veal						
Home supplies	605	48.9	510	48.5	652	77.7
Imports	631	51.1	542	51.5	187	22.3
Total	1236	100.0	1052	100.0	839	100.0
Total meat						
Home supplies	1319	46.7	827	38.4	1201	56.5
Imports	1508	53.3	1325	61.6	925	43.5
Total	2827	100.0	2152	100.0	2126	100.0
Consumption per hd.	*lb.*		*lb.*		*lb.*	
Beef and veal*	55		42		33	
Total	129†		94		88	

Sources. *Annual Abstract of Statistics.*
**Meat.* Commonwealth Economic Committee, 1952.
†1934–38 average.

Over the past decade great improvements have been made in milk production in this country, with the result that liquid milk requirements are almost satisfied. Yet there are still great possibilities of raising efficiency in this field. The national average yield per cow is not very satisfactory and complacency should be avoided until yields have been raised by at least a third. With the higher average yields, present supplies could then be achieved from 25 per cent fewer dairy cows. Another disquieting feature in milk production is the effect of disease, and partly as a result of this the average milking life of the dairy cow is only about three years. There seems no reason why this period should not be increased to five years in the near future. With higher yields and longer life, fewer dairy cows would be required and large acreages of land would be released for other uses. Further, the present high standard of buildings demanded for milk production imposes a limit on the numbers of dairy cows kept on farms. As a result land may be understocked. But buildings unsuitable for milk production could very well be utilized for beef cattle. This would result in better utilization of both buildings and land, and any surplus labour could be put to profitable use. There does appear to be room for extension of beef production in this country.

Beef as a Subsidiary Enterprise What is the attitude of the British farmer to beef production ? He is undoubtedly influenced by the rather gloomy picture conjured up by the reports on winter fattening published by the Provincial Agricultural Economists. These reports suggest that the beef fattening enterprise compares very unfavourably with milk and other lines of production and, considering beef as a main enterprise, there is little doubt about their accuracy, for the receipts from a main enterprise have to cover fixed and other costs. Beef production on most farms, however, can be regarded as a sideline, the animals being used to consume by-products that would otherwise be wasted or ploughed in. Animals may also be introduced into the farming system in order to make better use of certain resources. For instance, a few cattle can make use of surplus labour, or of a building which would otherwise remain empty. In such circumstances the allocation of total costs cannot be helpful to the farmer in deciding whether to include beef in his organization. A supplementary or complementary enterprise should be assessed on the basis of whether it contributes to the farm profits, and provided it more than covers the direct costs involved, then it can be profitably introduced.

The direct charges involved in beef production are mainly food costs, and they are of sufficient importance to warrant particular attention. The beef animals will be in direct competition with other animals for food supplies, and the farmer will be guided here by the returns he obtains from feeding to different animals. For instance, if dairy cows return 30s. for a £1's worth of food compared with 25s. for beef, then he would be well advised to feed the dairy cows more intensively. There does come a point, however, at which the efficiency of the dairy cow will diminish. This is likely to happen as production is pushed up to higher levels. It will then pay the farmer to transfer resources from dairy cows to other animals. Beef animals offer a reasonable alternative.

Choosing the Most Economical Feed The total cost of the finished beef animal varies widely with type, systems of rearing, age and weight, as well as the kinds of ration fed. Reference to past Provincial Reports suggests that this cost would amount to at least £60 for a three-year-old animal, weighing 10½ cwt. Hand-fed foods and

grazing would account for about two-thirds of this total. Data relating to the fattening process only indicates still more conclusively the importance of food costs. On average, no less than four-fifths of the costs involved in the "finishing" process represent charges incurred on foods. It is, therefore, extremely important to discover possible methods of economizing in the feeding of beef cattle. Some alternative rations are set out in Table 2 below.

Table 2

Some Alternative Rations for a 9 cwt. Bullock gaining 2 lb. Live Weight Daily

Daily Ration*		Starch Equivalent (S.E.) †	Protein Equivalent (P.E.) †	Cost per day	Cost for 150 days	lb. S.E. per lb. Live-weight Gain	Cost per ton
	lb.			*d.*	£		£
1. Hay	20	7.40	.92	11.55			5.39
Purchased cake	8¾	5.64	.90	35.63			38.00
		13.04	1.82	47.18	29.49	6.52	
2. Hay	8	2.96	.37	4.62			5.39
Swedes	39	2.85	.27	9.65			2.31
Dried sugar beet pulp	8	4.85	.41	17.14			20.00
Oats and beans (1 : 2)	4	2.55	.63	8.40			19.61
		13.21	1.68	39.81	24.88	6.60	
3. Hay	8	2.96	.37	4.62			5.39
Mangolds	114	7.07	.46	21.01			1.72
Oats and beans (1 : 2)	5	3.19	.78	10.50			19.61
		13.22	1.61	36.13	22.58	6.61	
4. Oat straw	11	2.20	.10	2.83			2.40
Arable silage	50	6.40	.85	14.84			2.77
Crushed oats	2	1.19	.15	2.79			13.00
Dried grass	5	3.01	.55	11.25			21.00
		12.80	1.65	31.71	19.82	6.40	
5. Grass silage (2nd quality)	88	11.09	1.50	20.55			2.18
Grass silage (1st quality)	22	2.82	.42	5.14			2.18
		13.91	1.92	25.69	16.06	6.95	
6. Hay	8	2.96	.37	4.62			5.39
Marrowstem kale	64	5.76	.90	10.83			1.58
Oat straw	7	1.40	.06	1.80			2.40
Oats and beans (1 : 2)	4	2.55	.63	8.40			19.61
		12.67	1.96	25.65	16.03	6.33	

* These rations are merely examples of the combinations of foods which would give the necessary nutrients for a 9 cwt. bullock.

† Analyses from W. M. Ashton's *Elements of Animal Nutrition.* Published by Charles Griffin and Co. Ltd., 1950.

These are suitable for 9 cwt. bullocks fed indoors, and are designed to meet maintenance requirements and 2 lb. liveweight gains per day. The fattening period covers 150 days. It is assumed that at the beginning of the fattening period the maintenance requirements of a 9 cwt. bullock are 6.0 lb. of starch equivalent (S.E.) and 0.6 lb. of protein equivalent (P.E.). It is also estimated that 2.5 lb. S.E. and 0.55 lb. P.E. are required for the first pound liveweight gain, and 2.5 lb. S.E. and 0.25 lb. P.E. for the second pound. Maintenance requirements increase as fattening proceeds, and the production ration will also have to be stepped up since the animals do not fatten so readily towards the end. However, the rations set out in Table 2 refer to the average requirements, and will have to be adjusted slightly from week to week. The dry matter requirement for the period varies from 25 to about 35 lb. per day. Some of the rations do not provide adequate dry matter, but it is assumed that straw for bedding will be available, and that the animals will satisfy their appetites with this.

The costs of the different foodstuffs included in the rations are based on national average cost of production and yield figures for 1951, the costs being adjusted upwards to represent present-day conditions. The more efficient farmers would naturally obtain much higher yields and incur lower costs of production. Ration 1 includes purchased concentrates at £38 per ton, and is the most expensive in the group. It has been deliberately included in view of the ending of feed rationing later this year. It appears that, with average costs of production, Rations 5 and 6 offer distinct possibilities of economizing on food. It is unlikely that fattening on silage alone is practised to any great extent in this country, but Ration 5 suggests that there is considerable scope for its introduction. Feeding trials carried out during the 1948–49 winter period at the Agricultural Research Institute, Hillsborough, Co. Down, and reported by Professor J. Morrison and W. A. Stephenson*, " showed that it was possible to fatten bullocks satisfactorily and profitably on a ration composed entirely of grass silage". From the cost point of view, some of the rations have distinct advantages over others, but no indication is given of the acreage of land required to grow these rations. Accordingly, data based on average yields have been calculated, and the land required to produce the food necessary to meet each of the six rations for ten bullocks for 150 days are set out in Table 3, together with the estimated gross margins realized.

Costs, Land Requirement and Profits The information shows that the average requirements of the ten bullocks vary widely according to the type of ration fed. In the case of hay and silage, only half the acreage has been included since it is assumed that the fields will be available for grazing soon after the harvesting. It seems that Ration 5 will require the greatest acreage-equivalent, followed by Rations 3 and 4. As regards the estimated gross margins, it is assumed that the bullocks are purchased in October at an average of £50 per head. The assumption is also made that they are sold in March grading out at A plus and, therefore, averaging 139s. per cwt. and £78 per animal after allowing for a deduction of ½ cwt.

Assuming no other costs, the gross margin per animal varies from a negative gross margin of £1 for Ration 1 to £12 for Rations 5 and 6. Per acre equivalent, Ration 6 gives a gross margin of £18, and Ration 5 a gross margin of £13.35. It is realized, of course, that as far as Ration 6 is concerned, the marrowstem kale will not be available throughout the fattening

* Winter Fattening of Bullocks with Grass Silage. *Agriculture*, 1950, 57, 251-6.

TABLE 3

FOOD REQUIREMENTS AND COSTS OF 10 BULLOCKS FOR 150 DAYS AND ESTIMATED GROSS MARGINS

Ration	Total Requirements	Assumed Yield per Acre	Acreage-Equivalent Required	Total Food Costs	Assumed Cost of Stores	Cost of Food and Stores	Total Receipts from Graded Animals	Gross Margin Over Feed Costs		
								Total	Per Acre Equivalent	Per Bullock
	tons	tons		£	£	£	£	£	£	£
1. Hay	13.39	1.45	4.61							
Bought cake	5.86	—	—							
			4.61	294.87	500	794.87	781.87	-13.00	-2.82	-1.30
2. Hay	5.36	1.45	1.85							
Swedes	26.11	12.72	2.05							
Dried sugar beet pulp	5.36	—	—							
Oats and beans ..	2.68	.98	2.73							
			6.63	248.81	500	748.81	781.87	33.06	4.99	3.31
3. Hay	5.36	1.45	1.85							
Mangolds	76.33	26.03	2.93							
Oats and beans ..	3.35	.98	3.42							
			8.20	225.81	500	725.81	781.87	56.06	6.84	5.61
4. Oat straw	7.37	—	—							
Arable silage	33.48	6.71	4.99							
Crushed oats	1.34	1.05	1.28							
Dried grass	3.35	1.00	1.67							
			7.94	198.20	500	698.20	781.87	83.67	10.54	8.37
5. Grass silage 1st quality	58.92	4.05	7.27							
„ „ 2nd „	14.73	4.05	1.82							
			9.09	160.56	500	660.56	781.87	121.31	13.35	12.13
6. Hay	5.36	1.45	1.85							
Marrowstem kale ..	42.85	19.94	2.15							
Oat straw	4.69	—	—							
Oats and beans ..	2.68	.98	2.73							
			6.73	160.31	500	660.31	781.87	121.56	18.06	12.16

period, except in the milder areas of the country, and silage would have to be provided during the latter stage of fattening.

The data suggest that there is scope for yard fattening at the present moment, particularly as a sideline. It may be argued that the figures set out are unrealistic and take no account of the other costs involved. But it cannot be denied that foods account for the major part of the cost. Further, it is estimated that each bullock will produce some 5 tons of farmyard manure during the period, and no allowance has been made for this in Table 3 (p.19).

Such are some of the considerations regarding the feeding of beef cattle. The present economic plight of the country demands an all-out effort to increase production at home. The British farmer has already provided ample evidence of his industry, loyalty and perseverance. Yet a little more ingenuity in the use of by-products and the fuller utilization of land, labour, and capital, can contribute substantially to farmers' profits and to the nation's larder.

COUNTY REPORTS ON THE EAST COAST SEA FLOODS

THE full assessment of the loss to British agriculture caused by the east coast sea floods on the night of January 31 cannot be made until every affected field has been finally surveyed. But the picture is taking shape, as the following county reports show.

East Riding, Yorks The narrow neck of land between the Humber and the sea terminating in Spurn Head, is part of Holderness—an area of strong fertile soils devoted to arable farming, in which wheat, spring barley, peas for drying, seeds and some beans are the main arable crops. Dairying, fat cattle, together with pigs and poultry, are the chief livestock enterprises. During the night of January 31, 1953, the sea breached the low cliff and sea-wall just south of Easington and some four miles north of Spurn Head. The sea water flowed in a south-westerly direction across the intervening two miles of land to fall into the Humber between Skeffling and Kilnsea. At the same time, the flood tide was surging up the Humber, topping and breaching the river bank in many places. In all, over 4,000 acres of agricultural land were flooded directly from the sea or from the Humber, involving some or all of the land and premises of sixty-eight holdings. There were also small encroachments on agricultural land at Paull and Barmston. This was the northern limit of the sea water flooding.

The water varied in depth up to about 12 feet but generally was 3 to 4 feet. Of the 4,000 acres of agricultural land, 2,400 were tillage and 1,600 permanent and temporary grass. Of the tillage land, 700 were sown to winter crops, including 500 acres of wheat.

The stock losses comprise : 25 cattle, 319 sheep, 98 pigs, and some 2,474 head of poultry. Premises suffered to a varying degree, but there does not appear to be any serious structural damage to main walls. Temporary structures, such as lean-to sheds and poultry-houses were, however, seriously damaged. Feedingstuffs were damaged in barns, and outside a considerable

quantity of coarse fodder was washed or blown away, and mangold pies were submerged. Equipment suffered too.

Farmers had little or no warning of the impending flood other than from those few who were outside during the evening and noticed that inland drains suddenly began to flow upstream. Fortunately, the East Riding suffered no loss of human life, and evacuation of livestock proceeded as quickly as possible. With the wholehearted co-operation of nearby farmers on high ground, the rescued stock were quickly accommodated in temporary quarters.

The flood water receded fairly quickly, much of the land reappearing after one to three days submersion. By the end of the first week, all but about 150 acres were cleared of flood water and the outlets of the main internal drains were running freely. Happily, the force of the flood water was insufficient to scour the land deeply and, although some ditches were silted, the main work of clearance has been the removal of straw, branches and similar flood debris. In one instance bales of hay blocked the main ditch and defied all efforts at removal until an excavator was put on the job.

At the time of writing (March 2), all the premises were re-occupied and the livestock have returned from temporary quarters. Ditch cleaning proceeds, but concern is felt about the condition of tile drains, as most fields in this area are underdrained.

Of the land itself, it is still early to say much. Each field has been soil sampled and special samples taken from patches where flood water settled. As soon as the main flood water had receded, fire service pumps were brought into action to relieve low-lying patches and to pump the salt water from field ponds. The field work for the farm survey to assess damage is complete, and the work of plotting and collating the information proceeds.

During the past six years parts of the East Riding have suffered from several blizzards and the extensive river flooding of 1947. The area of flooding involved in 1947 was much larger than that in the present occurrence, but sea water has a more prolonged and harmful effect. Just how long the period will be before normal cultivation can proceed again throughout the area must remain uncertain until fuller information about the soil conditions is available.

R. B. Ferro,
County Agricultural Officer

Lindsey, Lincs It is invidious to deal with the coldly technical aspects of such a tragedy as the flooding of many parts along the Lincolnshire coast on the night of January 31, 1953. In addition to the loss of human life, one of the most striking features is the damage to dwelling houses. Not only is there severe structural damage in some cases, a considerable amount of light structural damage in many others, but the salt water and a very considerable amount of mud and sand which were carried into the houses has upset the home life of a very large number of people.

The direct agricultural loss in stock drowned is likely to be smaller than was at one time feared ; but many cows became chilled through standing about in the water and have had to be sold for slaughter. Farmers, stockmen and cattle lorry drivers worked indefatigably all through the night of the flooding and throughout the following day, almost always under con-

ditions of discomfort and sometimes of no little danger. How quickly these rescue workers were on the scene, considering that Sunday night is the most difficult night in the week on which to get help or any outside services, was amazing. All day Sunday the winds were strong and heavy waves were whipped up in the flooded areas. One has to be acquainted with the Lincolnshire marshes to appreciate the difficulty of driving lorries over the flooded roads. In the early stages of the flood, only those with intimate knowledge of the roads could move. Most of the fields are bounded by dykes and drains ; hedges or fences are rare. For long stretches, therefore, there was nothing to show where the road ended and the roadside ditch or drain began. Quite a number of vehicles went off the road into a considerable depth of water.

Many animals had, of necessity, to fend for themselves ; some sheep for instance, when allowed their freedom, managed to get on to the sandhills. Perhaps the most interesting story is that of a pig which was believed drowned when all its companions were moved to safety. Some days later, however, this pig was found on top of a potato clamp, where it had obtained both " board and lodging," eating the potatoes and making its bed in the warm straw, down to which it had worked through the covering of soil.

Of a total flooded area of about 22,000 acres, 14,000 were arable, including about 4,000 sown in the autumn, most of it with winter wheat, and 8,000 acres of grass. It will not be easy for some time to define all the flooded land. There is a considerable acreage which was never actually under sea water but became thoroughly saturated by salt water which backed up the drains, the ditches and the under-drains into the soil of the fields.

Throughout much of the coastal area, the land is strong clay, where recovery from salt damage is known to be slow. There are, however, pockets of silt (some quite light silt), the largest being on the coast halfway between Mablethorpe and Grimsby. It is in these areas of silt that farming can be expected to start first ; some of the lighter soils may be cropped this year.

In many instances, only parts of farms are flooded ; and the severity of the blow to the farmer depends on how much of his land was affected by salt water. Unfortunately, there are many men whose whole farming has been affected, and on the neavy clay, particularly, farmers are naturally worried and anxious about their future.

A considerable area of the 8,000 acres of grassland affected by the flood may be difficult to deal with, at least during the early part of the summer, because the stock on this land depend on water from the field dykes. The present dry weather, although of value to most of the county, is definitely against the restoration of the flooded areas, where heavy rain would not only start to wash the salt out of the land, but would also wash much of the salt water out of the dykes by pressure of fresh water from the higher land. Normally, these marsh fields are grazed early in April, and if full value is to be obtained from them there will be a problem in getting water to the stock.

A. MANN,
County Agricultural Officer

COUNTY REPORTS ON THE EAST COAST SEA FLOODS

Holland, Lincs The county of Holland was fortunately spared the havoc and destruction which the sea wrought upon the neighbouring counties of Lindsey and Norfolk, but we were not left entirely unscathed. Along the estuary of the Witham there was some spill over but no bursting of banks. At Boston the lower parts of the town were flooded to a depth of several feet, and the noted landmark Boston Stump (the Parish Church) had its heating put out of commission. No lives were lost, nor was there serious damage to property.

In the estuary of the Welland the gale and tide struck with greater force and, in addition to overflowing as far inland as Spalding, the banks nearer the sea were breached in places and the tidal waters swept over acres of valuable arable land, only to be arrested by the old Roman Bank farther inland.

On the other side of the Welland, the new sea-bank protecting some 1,700 acres of land enclosed in 1949 was breached, strange to say at what was considered its strongest point, allowing the sea to tear a 60-yard gap and thus flood some 700 acres of reclaimed marsh which had been drained, levelled and partially reseeded. This land carried some 800 odd sheep, of which all save three escaped to higher ground, and though the farmer in this case is farming on a large scale, little keep was available on an otherwise all-arable farm and the sheep had to be transported to Rutland.

Farther down the coast, the sea-bank was breached, thus flooding several hundred acres of arable land, mainly in the occupation of smallholders who will feel acutely the loss of crops such as strawberries and bulbs, to say nothing of other and future cropping.

Being mainly an all-arable area, our losses of livestock were insignificant and damage to buildings and equipment practically nil. Potatoes in clamps, though flooded, were soon shifted, and losses therefore were slight. Other produce such as corn in stacks, etc., was relatively unaffected.

The losses of field crops, however, is a matter of some importance : approximately 180 acres of wheat, barley and beans, 40 acres of clover and seeds, and a fair acreage of strawberries and bulbs were lost.

On the whole, some 700 acres of arable and 800 acres of rough grazing (700 newly reclaimed) were flooded from one to six days. But it is not only the land which has been under water that concerns us ; a larger acreage is likely to suffer through the salt water backing up the dykes and field drains. the effect of which may show up in the crops later on in dry weather.

The immediate problem of many whose holdings have been flooded is what to do with all the boxed potatoes in their chitting houses. At this stage one cannot say whether their land will be fit for potatoes ; so much depends on soil and weather conditions, or until the results of soil analysis which is being pushed forward with all speed, are determined. These potatoes may have to be disposed of elsewhere, a matter which is easier said than done. Nevertheless the fact remains that some growers (one for instance has 30 tons of certified Scotch Seed which cost him £18 10s. a ton last autumn) stand to suffer a considerable loss.

Apart from the immediate loss, there is the uncertainty, and the potential loss of crops in the current year and perhaps for a few years to come. Even so, our farmers are not unduly pessimistic as they hopefully await the determination of the salt content by soil analysis. In the meantime dykes and ditches are being cleaned out to get the water away, but our farmers,

who have learnt from the experience of others, are not in any undue haste to carry out spring cultivations. They are content to wait awhile and to take advantage of technical advice on cultivation and cropping.

W. A. Scriven,
Assistant County Agricultural Officer

Norfolk It is regretted that at the time of going to press, it has not been possible for the Norfolk C.A.E.C. to make a statement on the flood disaster in their county.

East Suffolk In East Suffolk there was not a single river estuary or valley which was not affected by flooding. The total area inundated was 20,308 acres, comprising 16,275 acres of marshland and 4,033 acres of arable. How soon this land can be restored to full production depends on a number of factors, in particular the duration of flooding. On the River Deben, where 3,579 acres were affected, some 2,000 acres of arable were under water for over two weeks. Again, in the Ore estuary, in the Blyth and Waveney valleys, deep flooding persisted for over a fortnight. Five weeks after the disaster, some 1,500 acres were still under water, owing to unsealed breaches requiring a major engineering job and the colossal task which a few pumps had to face.

It is difficult to say whether the flooding of the arable is of more serious consequence than the flooding of the marshes, for both play an important part. During the past four years, the marsh farmers have realized the arable potential on the low land and have obtained excellent results—in terms of 12 qrs. of wheat per acre in some cases. Both are serious losses, but the marshland presents an immediate problem, for the coastal upland is all very light soil almost wholly utilized for arable. Practically everyone has a herd of cows and some are heavily stocked ; now some of these farmers will be without a blade of grass. In addition, a large head of cattle from interior farms are accustomed to spend the summer on marsh grazings. On the marsh, 1,045 acres of wheat, 90 acres beans and 810 acres of other crops have been lost or seriously affected. This loss is one thing, the continuing loss is another ; and the problem arising from the loss of potential milk and stock sales has also to be remembered.

Livestock losses might have been worse : they totalled 146 cattle, 303 sheep, 86 pigs, 11 horses and 1,289 poultry. Damage to buildings has been more of a nuisance than a real problem ; five sets were completely destroyed, and there were 39 other cases of moderate damage.

Soil sampling for salt content is now proceeding, but it would be misleading to quote the varying results at this stage. The areas which have lain under water from two to three weeks cannot yet be sampled. Areas which were flooded for only a few days would obtain some benefit from immediate rain, and a wet summer would no doubt help the whole situation.

On the vital importance of drainage, a preliminary survey seems to indicate that the ditches have been left in very fair order. Dredging by excavator will be required where the clay of a break has filled the delph ditch behind. All sluices will require inspection, for much debris has been cast on to the marshes and is finding its way to the sluice where it can be caught up in the sluice door.

P. J. O. Trist,
County Agricultural Officer

Farmers Weekly

VIGIL

With the sea-walls broken in hundreds of places along the coast from Spurn Head to North Kent, the spring tides on the night of February 13-14 were watched with anxiety. Would the temporary repairs hold? Many patrols kept a lonely vigil, as here at Wingland, Lincolnshire, but fortunately the crisis passed without incident.

P.A.—Reuter Photos Ltd.

Yorkshire. A flooded farmhouse near Spurn Head.

Essex. Submerged farmland on Foulness Island.

Aerofilms Ltd.

The Grower

Kent. Flooded glasshouses on a holding at Belvedere.

Norfolk. Wrecked houses and farm buildings at Salthouse.

Sport and General

FERTILIZER PLACEMENT EXPERIMENTS ON THRESHED PEAS (See pp. 34–8)

G. W. Cooke

Special drill built by the National Institute of Agricultural Engineering for fertilizer experiments carried out by the Rothamsted Experimental Station.

N.I.A.E.

Prototype tool-bar mounted drill used in the N.A.A.S. fertilizer placement experiments.

COUNTY REPORTS ON THE EAST COAST SEA FLOODS

Essex On the night of January 31, 49,000 acres of Essex were inundated by the sea. In very broad terms, the greater part of the coastal fringe was flooded to an average depth of half a mile inland. All the islands on the north bank of the Thames Estuary forming the south-east corner of Essex (not to be confused with Canvey Island) and covering an area eight miles long by five miles wide, were completely submerged by the tide. A month later, they are still under water.

Agricultural land accounts for 41,000 acres of the total area and is made up of 7,000 acres of winter-sown corn, 11,000 acres of other arable and leys, and 23,000 acres of pasture, of which not more than 3,000 acres are rough grazing. At the time of writing (March 2) the water has receded from all but 10,000 acres.

The livestock casualty figures are astonishingly low—due to the natural instinct of loose animals to bolt for higher ground. To date the recorded casualties are : cattle 259, horses 6, sheep 1,008, pigs 478, poultry 7,177. Practically all the cattle drowned were either tied up or in cattle yards.

Two hundred and fifty-six ricks of all types were damaged, and many of these will be written off as a total loss where it has not been possible to thresh them immediately ; many started steaming within a few days. Threshed corn is being salvaged. Stocks of fertilizers will almost certainly be a total loss.

Approximately 410 items of agricultural machinery of all types were submerged, but the extent of permanent damage or total loss will depend on how quickly and effectively owners are able to clean them of salt ; some will be damaged beyond recovery.

Farms totally inundated have already disposed of all livestock that survived the flood ; farms partially inundated are now faced with the sad task of reducing their livestock to the carrying capacity of the unaffected portion of the farm. One of the biggest problems is going to be retaining the workers on these farms. It will be some time before it will be possible to employ the full farm staff on the land, but wages will have to be paid in spite of reduced income or no income at all. If these men leave the coastal farms they are not likely to return, and the lack of amenities and the memory of January 31, 1953, will be strong deterrents to fresh workers and their families. When the land is again fit for cultivation, what use will it be to the farmer if he has no men to work it ? Most of it is silt overlying London clay and the worst affected area has the lowest rainfall in Britain, a combination of factors which suggests that the period of recovery for the land will be longer than the average expectation based on previous experience of sea-water flooding.

The magnificent response of farmers and farm workers throughout the county to the call for help will stand as a shining example to future generations : 4,000 farmers and farm workers volunteered to help secure the sea defences before the next critical tides, enabling a force of 2,000 skilled workers to be maintained on the job daily. It would be impossible to measure the value of this body of skilled men to supplement the servicemen and other forms of recruited and voluntary labour. By this and the many acts of courage, devotion to duty and loyalty by farmers and farm workers in the saving of human and animal life in this tragic disaster, the history of Essex agriculture will be much enriched.

D. C. Bower,
County Agricultural Officer

COUNTY REPORTS ON THE EAST COAST SEA FLOODS

Kent In the early hours of February 1 the sea broke through about 200 breaches in the sea walls protecting the low-lying farmland along the north coast of Kent from Woolwich to Deal. An early survey the following day revealed that nearly 50,000 acres of the county were under water; residential and industrial properties occupied about 7,000 acres of the total, and the remainder was agricultural.

The land was under flood to a depth of up to 10 feet or more in places, and 32,000 acres of grassland were affected. These were good pastures, although not so well known as the famous Romney Marsh grazings, which fortunately escaped flooding. The first job was to rescue what was left of the livestock cut off on knolls and sea-walls. It was estimated that some 24,000 sheep and 5,000 cattle were grazing or yarded on this land before the floods.

An emergency organization comprising the N.F.U., the C.A.E.C., N.A.A.S., River Board, Local Authorities and Service Departments was set up on Monday, 2nd. During the first hours farmers, workers and voluntary helpers had performed many heroic and dangerous acts in rescuing animals, but now it needed special equipment, and the Services soon had personnel and all manner of craft on the scene. The Island of Sheppey (Isle of Sheep), 22,000 acres, had 12,000 under water; the bridge, about 70 yards long, over the Swale, was now in the middle of a stretch of water four miles wide. By the 4th, all stock in danger had been got on dry land, and two days later all were secure and being cared for. The organized rescue work brought in nearly 1,000 cattle and 7,000 sheep, but many more were rescued by individual efforts of farmers and volunteers.

Then came the reckoning of the dead. A survey of all the holdings affected (302) showed that 430 cattle, 6,630 sheep, 500 pigs, 47 horses and 2,500 poultry had been drowned—a heavy toll in spite of the good rescue work.

As the waters began to recede after a few days, the dead stock began to appear in great numbers, and all help had to be called in to dispose of the carcasses. Mass graves were dug by excavator, and by now nearly all the dead are accounted for.

The next problem was agistment of the evacuated stock, and the splendid response from farmers and others who offered grazing and yards soon had all the animals in temporary quarters. But there is a longer term problem here—the flooded grazings will not be much use this year at least.

The arable land, about 7,000 acres, was mainly on the upper limits of the flooded area, but preliminary salt tests show that nearly all is over the danger mark for crops until it has been rested and treated with gypsum. Some 3,000 acres were under crops, including over 1,600 of winter wheat. Much of this arable is good early potato land which had been prepared for planting.

The famous Kent orchards did not escape, and some fine apple, pear and cherry orchards, about 600 acres, are feared to be a total loss.

Three acres of glasshouses were flooded and wrecked, and about 2,000 acres of market-garden land will have too much salt for cropping.

It is, as yet, too early to assess the total damage or loss of production, but the soil chemists and advisory officers are hard at work testing soil and water samples and telling farmers, only too anxious to get going again, that they must keep off, otherwise the soil texture will be ruined for years to come.

There is no room in this short note to mention all who helped in the relief work, but to all those known and unknown helpers grateful thanks are given.

R. Duncan,
County Agricultural Officer

THE TREATMENT OF FARM LAND FLOODED BY SEA WATER

J. HARGRAVE, B.Sc.
National Agricultural Advisory Service, Eastern Province

THE flooding of farm land by sea water usually results in great damage to crops and soil. Growing crops, whether arable or grass, may suffer a serious setback in growth or, if the flooding is prolonged, be killed outright. The injury to the soil structure is often severe and of long duration.

The inundation of a crop by sea water for any considerable time will result in waterlogging of the soil and the exclusion of air. Vegetation may be completely killed or the roots so damaged that subsequent recovery is only partial. Salt in the water adds to the injury caused by flooding. This may not take place at once, but after the water gets away and the soil starts to dry, scorching and withering of the foliage may occur. The extent of the damage will depend on the amount of salt in the water and the susceptibility of the crop to salt injury.

Damage is reduced if flooding occurs during cold weather, when the crop is not in active growth, but submersion for one or two days is, in most cases, sufficient to cause severe injury. The condition of the soil at the time will have a considerable influence ; if open and dry, penetration by the sea water will, of course, be greater than where it is moist and fairly compact.

Arable crops usually suffer more severely than permanent grass, under which the tilth is more stable and the soil more compact. Many grasses have a fair power of recuperation after flooding, but the number of grazing days obtainable are bound to be reduced and, in the case of severe injury, the effect may last for three or four seasons. The clovers may be killed out for a time and then re-establish themselves.

Penetration of Salt and Effect on Tilth Probably the most serious effect of sea water flooding is its effect on soil tilth. In a normal soil a proportion of the soil minerals—calcium (lime), potassium, magnesium, sodium—are held in a loosely held condition on the clay particles and on the organic matter fraction. The calcium predominates in most soils and has the effect of promoting granulation and the formation of a porous structure. During flooding, the sodium in the sea water replaces most of the calcium, and the sodium clay thus formed has most undesirable properties. It lacks the power of granulation and forms impervious sticky masses when wet, which, on drying, set into hard, compact lumps that are very difficult to break down. Thus the structure of the soil is destroyed, the natural drainage channels of the soil become blocked, and cultivations, if attempted too early, serve only to aggravate matters. Often the sodium does not penetrate to the centre of the natural soil units, but is absorbed on the outside. This fact is important because, where cultivations are carried out too soon, the remains of the natural structure is broken down and the sodium is liable to penetrate and exert its harmful effect throughout the whole soil.

In view of the adverse effect on tilth, the depth to which the sea water has penetrated into the soil becomes of great importance. Penetration is greatest on dry soils of coarse texture, and least on heavy, wet, close-textured soils. Heavy land, when dry, may develop cracks which extend down some way

into the soil, and these will enable the water to penetrate more easily. Destruction of the tilth of soils is increased by the weight of water covering them.

Cautious First Steps The first step towards restoration must be to get the drainage working satisfactorily again, by clearing blocked ditches and leading off any water standing on the surface. Where sand has been deposited in heaps or ridges on a field, no attempt should be made to level or remove it by the use of bulldozers until the soil structure of the field has recovered.

When the drainage has been cleared, the temptation to take further action will be great, but it must be resisted. The most urgent need is for rain to help to wash out the salt from the soil. If the surface has been panned, then the drawing of furrows may help to take off the water and so remove some of the salt and prevent it from penetrating into the soil. Great care will be needed to avoid damage by implements at this stage.

Where small, level acreages of valuable crops are concerned, irrigation with fresh water might be attempted.

The soil should be allowed to become well dried out before any serious cultivations are done. Failure to allow time for this to happen may result in damage to the soil texture that will remain for a very much longer period than if the soil had been left untouched.

Restoration Where land is carrying a crop at the time of flooding, and where the injury is light, owing to the water being only slightly salty or on the land for only a very short time, the application of a nitrate fertilizer such as "Nitro-Chalk" at 2–4 cwt. per acre will generally be of benefit. Nitrate of soda should not be used, because of its sodium content.

Grassland will benefit from this treatment, and on soils that are low in phosphate 3–4 cwt. superphosphate per acre will assist root development and help in a small way to restore the tilth. More severely affected grassland should be left alone for some months to see what herbage survives ; if sufficient grass remains, a renovating mixture might be sown as soon as practicable.

Arable land that has been more severely damaged requires a different approach to its problems.

When it is reasonably safe to go on the land, very careful consideration must be given to the measures to be taken. A study of each field must be made carefully and the following points taken into account.

There are sure to be lower-lying patches where the water has stood for longer periods, and it is here that the salt content is likely to be highest. These parts must be considered individually when the soil is examined for salt content.

Examination of the consolidation and texture of the surface soil and of the underlying layers will give an indication how far the salt has penetrated, and this can be confirmed, if thought necessary, by taking soil samples at several depths to measure the amount of salt present at these levels.

Damage to the soil tilth will depend very largely on the soil type and how far the salt has penetrated, the damage being greater on heavier soils.

The application of gypsum may be of considerable help in restoring the damaged soil structure. For this purpose, the Ministry of Agriculture is making supplies available to farmers for use on arable land and most top

fruit orchards where the soil has been contaminated with salt. Gypsum will usually be delivered free at farms or to a local supply dump. When assessing the salt levels, the farm as a whole will be considered, and the gypsum distributed on that basis, if the farmer wishes to use it.

The rates provided for will be 2 tons per acre of the ground quarried gypsum or 50 cwt. per acre of a by-product gypsum with a moisture content of 20–25 per cent. These are the two main types available, and it should be possible to spread both these substances by fertilizer distributor or other suitable method. Gypsum will be of considerable help on acid soils, or where the reserve of lime is low ; the question whether it will be of so great a value in this country on flooded soils containing a large reserve of lime, is debatable. In view, however, of the possibility of gypsum effecting at least some improvement, its use on all types, irrespective of their lime content, has been approved, provided the salt content reaches a stated figure. Some soils may require further treatment with gypsum in the following season. It is not proposed to supply gypsum for grassland except where reseeding or extensive renovation is to be undertaken.

Gypsum should be applied as evenly as possible. Opinions vary as to the wisdom or otherwise of working the gypsum into the first inch or two. On the heaviest soils, Dutch workers have suggested that the soil is best left untouched after spreading, so that the gypsum may exert its full effect on the surface layer and depend on rain for solution and penetration.

On much of the severely flooded land the most likely time for the dressing with gypsum will be next autumn. Application after the land has dried during the summer months will then allow it to be washed into the soil by next winter's rain. Where a growing crop has survived, but the soil texture appears to be injured, the spreading of gypsum on top of the crop may be advisable.

An important point to be stressed is that the land must be in a fit state to withstand the passage of the distributor. If not, the damage done by the implements may largely counteract the effect of the gypsum.

Salt Tolerance and Choice of Crop Before cropping is considered, the salt should be at safe levels in the top 12 inches of soil, and preferably down to 18 inches. This is important as, if dry weather is likely to follow sowing, the salt will tend to move upwards in the soil with the normal movement of moisture. Crops show a fairly wide variation in their tolerance to salt, but the range given must be treated with reserve for many other factors come into play. For spring sowing (often the beginning of a period of low rainfall in the Eastern Counties), the lower limits should be chosen for safety.

Below 0.1 per cent of salt, the level is usually safe for most crops, although caution should be observed with beans and tulips, which seem to be extremely sensitive. Barley, rye, wheat and lucerne will stand between 0.1 and 0.2 per cent. Kales, rape, mustard and the grasses may stand between 0.2 and 0.3 per cent, and sometimes a little higher. Beyond these figures few crops will flourish or even survive.

It may be noted that root crops such as sugar beet and fodder beet have not been mentioned, as, although their tolerance to salt is fairly high (about the same as barley), it is not usually advisable to grow them on account of the amount of inter-row cultivation they require, and the soil disturbance necessary at harvest time. As a general rule, it is best to begin with crops needing a minimum of cultivation.

This is a limited list, but the first purpose in cropping should be the restoration of the soil. Until this has been accomplished, productivity and range of crops is bound to be limited.

The best crops for restoring the soil structure are undoubtedly the grasses and clovers, since their extensive root systems help to granulate the soil. But it must be remembered that the clovers are only moderately tolerant to salt.

Barley for its grain or cutting green is a good choice, and, for the latter, fairly heavy manuring with "Nitro-Chalk" will be required. Slightly less tolerant crops may be sown in autumn, when it is likely that the salt content may be further reduced by the winter rain. The spring and summer rainfall of the Eastern Counties is comparatively low, and there is no great likelihood that much reduction of salt will take place in a normal growing season, and, as has already been stated, the salt in the underlying layers of soil may be brought up by the natural rise of moisture. Greater care, therefore, must be exercised in the selection of a spring crop.

Land that has been flooded will usually require more nitrate nitrogen than on a normal soil, and the use of "Nitro-Chalk" has already been mentioned.

No reference has been made to top fruit orchards, but the general advice is much the same. Salt penetration to depth is likely to cause scorching and withering of the leaves, with possible complete defoliation. Where the concentration is high, the trees may be killed. The improvement of the drainage and the use of gypsum will help, and, in cases where injury is less severe, "Nitro-Chalk" will be of benefit. Trees suffering from adverse soil conditions may be more susceptible than usual to spray injury, and modifications in the spraying programme may be necessary.

For all crops, at whatever season they are put in, cultivations should be kept to a minimum. Ploughing should be avoided except when absolutely essential. It tends to bring up salt from below, but if it must be done it should be kept as shallow as possible. The tilth should be kept fairly coarse to prevent the soil running together after rain. It should be obtained, if feasible, by the use of discs or harrows only.

How Long will the Effects of Flooding Last ? It is very difficult to give a definite answer to this question. The amount of salt in the soil, its depth of penetration, soil texture, natural drainage, rainfall and treatment are all factors involved. It may vary from a few months on light soils where the flooding has been only slight, up to four or five years in the most severe cases.

At the time of writing (March 5) only a comparatively small number of soil samples have been analysed for salt content in the Eastern Province, but a summary of those done shows that 30 per cent contain up to 0.15 per cent of salt, 47 per cent contain 0.16 and 0.30 per cent, and 23 per cent contain over 0.3 per cent. These are probably from the less severely flooded areas, and it is likely that, as the bulk of the samples come in from the worst districts, the percentage in the higher groups will rise.

Summary A brief summary of the main points must be : (1) see to the drainage ; (2) the most important point of all, do not attempt to cultivate the land too soon ; (3) find out the salt content of the soil and treat with gypsum where needed ; (4) grow a tolerant crop and give adequate nitrogen.

THE FLOOD DISASTER IN THE NETHERLANDS

P. G. MEUWISSEN

Technical Assistant to the Agricultural Attaché to the Netherlands Embassy

IN the night of January 31, 1953 the inhabitants of many parts of the south-western area of the Netherlands, especially the coastal regions, were rudely awakened by the rumbling of an oncoming avalanche of water that swept all before it and left heavy destruction of life and property in its wake. Days of anxiety followed, during which the flood waters engulfed and submerged considerable areas, and the loss of life and damage wrought can, so far, only be estimated. It should be recorded that the immediate help that came from all quarters of the world greatly alleviated the distress—a fact which has aroused gratitude and pride from Government and people. This catastrophe has shaken the economic foundation of Holland, and it will undoubtedly take time and large sums of money before the country regains its balance.

The first phase of the battle against the water was the saving of life where possible. The second phase—already started before the end of the first—was the work of emergency repairs. The third phase—the restoration and rehabilitation of the flooded areas—will be started when and where conditions permit.

The areas which have been flooded lie within the south-western provinces of South Holland, Zeeland and North Brabant. In the main the parts which have been ravaged by the floods are agricultural and horticultural, with only little manufacturing industry. Had the floods reached the industrial areas, the damage to the national economy might have been fatal. Only in the outer fringe of the flooded area has some damage been caused to stocks and installations of some large and medium-sized factories. In these industries interference with production is likely to have no marked effect. It may be stated that, taking the country as a whole, the industrial output has not suffered.

Nearly Six per cent of the Cultivated Area

Very different, however, is the picture for the agricultural industry. A total of about 332,500 acres of agricultural land have been or are under water, and this is 5.7 per cent of the total cultivated area in the Netherlands. Of this 332,500 acres, about 205,000 acres are arable land (8.9 per cent of the total arable land), 102,500 acres are grassland, (3.1 per cent of the total), and 25,000 acres are horticultural land, (9.4 per cent of the horticultural area of the Netherlands).

Taking the cropping in 1952 as a basis, the arable land can be divided as follows—the figures in brackets indicating percentage of the total area of the particular crop grown in the Netherlands.

80,000 acres of cereals (15.2 per cent), including 30,000 acres of wheat (6.1 per cent)
34,250 „ „ ware potatoes (8.6 per cent)
37,500 „ „ sugar beet (24 per cent)
15,000 „ „ pulse crops (17.8 per cent)
18,750 „ „ flax (22.7 per cent)
and about 20,000 acres of other crops including nearly 8,000 acres of onions, (over 53 per cent).

The loss of stocks of agricultural produce cannot easily be assessed. It may be supposed that the major part of the 1952 crop had already been delivered, and part of the potatoes and flax in the flooded area can be saved.

Of Government stocks of cereals, feedingstuffs and oil seeds, only minor quantities are lost. Losses of stocks of this produce kept by local suppliers cannot be estimated.

The livestock population in the flooded areas is as follows:

Young cattle		102,000 (3.5 per cent)
Milch cows		41,000 (2.8 „ „)
Pigs (approx.)		40,000 (2.2 „ „)
Poultry	over	380,000 (1.6 „ „)
Agricultural horses		13,500 (5.1 „ „)
Sheep	over	9,000 (2.4 „ „)

According to preliminary estimates, the following numbers have been lost:

Cattle		25,000
Pigs		15,000–20,000
Sheep		2,000– 3,000
Horses (approx.)		1,500
Poultry	over	100,000

The remainder of the livestock kept in the flooded area have been evacuated and many farmers have suffered heavily. Losses of livestock were severe on the islands of Flakkee, Schouwen and Duiveland; between 80 and 90 per cent of the cattle on these islands perished. The damage to the vital food industries in the flooded area is believed to be not serious. Only the flax industry suffered considerably in some regions.

The emergency services for the supply of food, drinking water and clothing, as well as the evacuation of people and livestock were, with few exceptions, already terminated on February 5. Only Zierikzee, which was threatened subsequently, was evacuated by order on a later date. The total number of evacuees from all flooded areas is estimated at 100,000, and the number of people drowned is, as far as is known, 1,487, but it is feared that this number will be increased when the full facts are known.

It is not possible to estimate the quantities of food which have been supplied to the flooded areas, since not only the Ministry of Agriculture, Fisheries and Food, but also the Red Cross and other organizations, as well as private individuals, helped in the provision of food and drinking water. Measures were taken by the Government to ensure an adequate supply of essential food. Potatoes were subjected to price control as some speculation became evident. For some products, an export ban was introduced. The affected foods were potatoes, hay and straw. As the general position clarifies and in the light of developing circumstances, these measures will be withdrawn. Already this ban has been lifted as far as seed potatoes and several varieties of ware potatoes are concerned.

A start has been made with the storage of ware potatoes, agricultural machinery and implements from lightly flooded areas. As far as these potatoes are still wholesome, they will be distributed immediately, since their keeping quality has been impaired. Provincial Food Directors have been charged with the registration and distribution of fodder, etc., which has been made available by agricultural organizations and farmers for the flooded areas.

A census has already been started in a limited fashion so as to assess the amount of some produce still available in the flooded regions and, in some cases, of essential material for repair work in the entire country.

It has not been overlooked that the evacuation of livestock to collecting centres, often in great haste, incurs a danger of infection to healthy animals, especially tuberculosis. It will, therefore, be necessary to carry out tests where possible at the earliest opportunity. Fortunately, during the week

prior to the disaster the number of foot-and-mouth disease outbreaks in the three provinces was only very small, so it is hoped that the disease will remain limited, especially since large-scale vaccination was carried out recently. In addition, during the evacuation the animals were immediately vaccinated free of charge, and vaccine is available without charge at places where the cattle are being kept temporarily.

Restoration Preparations for the restoration of agricultural production in the flooded areas are being pushed forward energetically by the Government Agricultural Restoration Service. This service will work in close co-operation with the Agricultural Development Service. A Dutch expert serving with the F.A.O. has already been recalled. Much of the war-time organization will be set up again, and officers at present otherwise engaged who served in the above service will, where possible, be recruited. In various localities in the ravaged area Flood Damage bureaux have been established where victims may notify losses and damage. The Government Agricultural Restoration Service will take all suitable measures to promote a speedy restoration of the agricultural land, and assess other agricultural damage and loss, such as livestock, machinery, produce, etc., with the exception of buildings. In cases where restoration of the damage and farming activities are possible, advances may be applied for at the bureaux as from February 15 in anticipation of the settlement of a definite Government share in the restoration costs.

A start with restoration has already been made with the testing of the salt content of land from which the water has receded sufficiently for this to be done, and various scientific institutions are collaborating in this work. Attention is also being paid to materials required to lessen the deteriorating effect of salt on the soil structure. Measures have been taken to overhaul and repair tractors and machinery saved from the flooded areas, and the Advisory Service will assist farmers in the choice of crops which can be sown in areas which are sufficiently dry this season.

There are indications that it will be desirable to reallocate the land in the flooded areas according to the principle laid down in an Act for that purpose relating to Walcheren soon after the war, but only in areas where conditions would lend themselves to such action. The Government intend to lay down measures to that effect and place them before the States-General at the earliest possible moment.

It is anticipated that a small part of the inundated area will bear reasonable crops this year. Sugar beet and potatoes, in particular, will have to be grown on a large scale in other parts of the country to make up the deficiency in the flooded districts.

The repair work of the sea-walls will be undertaken by the Government in co-operation with the local Water Boards. If necessary, the work at present in progress at the Zuiderzee Polders will be temporarily slowed down to provide the necessary trained men, material and machines for the emergency work in South-West Holland.

The building of a main sea wall along the islands of Zeeland and South Holland has been studied since 1951. This wall would permanently close the sea arms between the islands and would shorten the dyke system considerably. It is, however, an immense project which is estimated to require technical and financial resources greater than for the construction of the Zuiderzee enclosure dyke. If the means were available, the work could be completed in twelve years. But there are economic considerations, however, involving shipping, oyster cultures, etc.

FERTILIZER PLACEMENT EXPERIMENTS ON THRESHED PEAS

G. W. COOKE, Ph.D., A.R.I.C.
Rothamsted Experimental Station, Harpenden, Herts
and
C. V. DADD, M.A., Dip. Agr. (Cantab.)
National Agricultural Advisory Service, Eastern Province

Results of trials with threshed peas carried out over the last six years on soils where phosphate and potash are low, show that by far the greatest response is obtained by placing the fertilizer at the side and slightly below the seed.

WITH the rapid development of the dried pea industry during the Second World War, the acreage in England and Wales devoted to the pea crop doubled, and peas were grown by many farmers who were hitherto unfamiliar with the crop. Some farmers, mindful of the spectacular results often obtained by combine drilling cereals on newly-broken grassland, attempted to use their combine drills for other crops such as peas. Sometimes they were successful but germination was often reduced, and it was obvious that combine drilling a compound fertilizer was unsafe in the dry seedbeds so common in an East Anglian spring. Nevertheless, if the gamble succeeded, there was no doubt that quick establishment and good yields were obtained.

Experience in America, where combine drills have been widely used, showed that it was possible to secure some of the benefits and avoid the risks of combine drilling by placing the fertilizer for sensitive crops in a band near the seed, but separated from it by an inch or two of soil.

Research on the application of this technique in Britain began in 1945 under the auspices of the Agricultural Research Council's Technical Conference on Fertilizer Placement. Since there were no drills on the market which placed fertilizer and seed in the soil by separate coulters and which were suitable for experimental work, the National Institute of Agricultural Engineering designed and built a special drill (illustrated on p. iv of the art inset). A "top-delivery" fertilizer system was fitted which could be relied on to deliver the same amount of fertilizer on different occasions with any one setting of the gears. The setting of the coulters could be varied so that bands of fertilizer were placed in any desired position near the seed. This drill was used from 1947 to 1950 by the staff of the Chemistry Department at Rothamsted to carry out field experiments on threshed peas and other row crops. The experiments were scattered over the eastern counties and were carried out mainly on ordinary farms. Local arrangements were made by officers of the National Agricultural Advisory Service, who inspected the fields offered for these experiments and arranged for analyses to determine whether the soils were suitable.

To compare the efficiencies of various methods of placing fertilizer, it was necessary to find sites where soil phosphate and/or potash reserves were on the low side. Unless there was some response to applied fertilizer, it was obviously not possible to compare the effects of different methods of application.

FERTILIZER PLACEMENT EXPERIMENTS ON THRESHED PEAS

Rothamsted Experiments Granular phosphate-potash fertilizers were used in the Rothamsted trials. In 1947 and 1948 the mixture contained 10 per cent P_2O_5 and 20 per cent K_2O ; in later years, fertilizers containing roughly equal proportions of phosphate and potash (for example, 15 per cent P_2O_5, and 13 per cent K_2O) were applied. Similar amounts were applied whether the fertilizer was broadcast or placed in various positions near the seed. The results obtained by averaging all the experiments in each year are summarized in Table 1.

The experiments in 1947 were devoted to finding safe positions for the bands of fertilizer. Broadcast fertilizer had little effect on yields, but there were sizable increases from dressings placed near to the seed. The heavy dressing of 6 cwt. per acre placed in contact with the seed gave much lower yields than the light dressing and also damaged the stand of plants at each centre. Good establishment and yields were obtained when fertilizer bands were placed either at 1 or 3 inches to the side of the seed. After this demonstration of the possible dangers of placement in contact, the method was not tested further.

Table 1

Yields of Threshed Peas given by Broadcast and Placed Fertilizer, averaging all Rothamsted Experiments in each Year

	Yield Without Fertilizer	Amount of Fertilizer	Yield with Fertilizer					
			Broadcast		Placed	Placed below Seed Level		
			On Plough'g	On Seedbed	in Contact	1 inch to side	2 inches to side	3 inches to side
	cwt. per acre	*cwt. per acre*	*cwt. per acre*	*cwt. per acre*	*cwt. per acre*	*cwt. per acre*	*cwt. per acre*	*cwt. per acre*
1947 3 Experiments	13.2	3	—	13.0	16.2	16.7	—	15.8
		6	—	14.0	14.5	16.1	—	16.7
1948 5 Experiments	12.6	3	13.7	13.8	—	15.7	—	15.6
		6	14.8	13.1	—	15.8	—	16.8
1949 6 Experiments	13.7	3.5	13.6	13.8	—	—	15.3	—
		7.0	14.5	14.3	—	—	15.3	—
1950 3 Experiments	16.1	2.3	16.3	16.3	—	—	17.5	—
		4.6	17.5	18.1	—	—	19.1	—

The 1948 experiments compared bands of fertilizer placed at 1 and 3 inches to the side of the seed with the same amounts of broadcast fertilizer. The two side-placement positions gave rather similar yields, and in all the later experiments the fertilizer was placed 2 inches to the side and about 1 inch below the seed.

Fertilizer placed at the side of the seed gave higher yields in all years than the same quantity of broadcast fertilizer. The single dressing of placed

fertilizer gave higher average yields than twice as much broadcast fertilizer in the experiments in 1947, 1948 and 1949, and similar average yields in 1950.

The increases in yields obtained from broadcast fertilizer and the gains from placed dressings are summarized in Table 2. This has been done by averaging the responses to broadcast fertilizer applied at different times, and to placed fertilizer applied in different positions. In all years the *extra* yield from placing, as compared with broadcasting the light dressing of fertilizer was greater than the increase from broadcasting alone. This was also true of the heavy dressing in all years except 1950. Over all the years the *extra* yield of peas given by placement over broadcasting was 1.9 cwt. per acre when the light dressings were used and 1.6 cwt. per acre for the heavy dressings.

Table 2

Increase in Yield of Threshed Peas from Broadcast Fertilizer, and Comparisons of Broadcasting and Placement

Year	Yield without Fertilizer	Increase in Yield from Broadcast Fertilizer at Low Rate	Increase in Yield from Broadcast Fertilizer at High Rate	Extra Yield from Placed over Broadcast Fertilizer at Low Rate	Extra Yield from Placed over Broadcast Fertilizer at High Rate
	cwt. per acre	*cwt. per acre*		*cwt. per acre*	
1947	13.2	–0.2	0.8	3.2	2.4
1948	12.6	1.2	1.4	1.8	2.3
1949	13.7	0.0	0.7	1.6	0.9
1950	16.1	0.2	1.7	1.2	1.3

In the experiments from 1948 to 1950 two methods of broadcasting were tested : early dressings were applied over the plough furrows before cultivating, while later dressings were harrowed into the seedbed. Yields given in Table 1 show that the two methods of broadcasting gave rather similar results except that, in 1948, the heavy dressing broadcast early over the ploughing gave higher yields than late dressings on the seedbed. Although in two seasons there was little advantage from early dressings, farmers who intend to broadcast fertilizer for peas are advised to work dressings deeply into the seedbed to ensure that the fertilizer is not confined to the upper layer of soil where it may be of little value in dry weather.

N.A.A.S. Experiments The experiments carried out by the Rothamsted staff were, particularly in later years, confined to areas within easy reach of Rothamsted. As the work progressed, the value of placement for threshed peas became clearer, and it was apparent that the experiments should be extended to more distant areas where peas are an important crop. The Agricultural Research Council arranged with the N.A.A.S. to extend the work, and experiments on threshed peas have been carried out by the staff of the N.A.A.S. in the Eastern Province in 1950, 1951 and 1952. This is a good example of research work initiated by a research institute being continued by the N.A.A.S. with the double object, first, of extending and confirming the findings of earlier work, and, second, of providing material to be used in demonstrating the practical implications to the farming community.

At the same time, the National Institute of Agricultural Engineering was considering the development of suitable drills which could be used to place fertilizer at the side of the seed of peas and other rowcrops. They designed and built a prototype drill which was used in the N.A.A.S. experiments. The drill (see art inset) consisted of four independent seed and fertilizer units

mounted on a tractor toolbar. A simple fertilizer delivery system of the "plate-and-scraper" pattern* was fitted, and a coulter arranged so as to place one band of fertilizer 2 inches to the side of the seed and about 1 inch below. A land roller smoothed the groove left by the fertilizer coulter and provided drives for the fertilizer and seed mechanisms.

The earlier Rothamsted experiments had shown that bands of fertilizer should be placed 2 inches to the side of the seed, and that fairly small dressings of placed fertilizer were sufficient for full yields. Consequently, the N.A.A.S. experiments were of a simple pattern, comparing only a light dressing (approximately 2.5 cwt. per acre) of placed fertilizer with the same quantity and with twice as much broadcast. Granulated mixtures of superphosphate and muriate of potash (containing 10 per cent P_2O_5 and 20 per cent K_2O) were used. Broadcast dressings were applied before sowing and were harrowed into the seedbed.

The experiments were carried out on a wide range of soils where the pea crop could be expected to respond to fertilizer. Two experiments were carried out in 1950 on fertile silt soils, but these failed to show any positive response to fertilizer no matter how it was applied. The average results of all the experiments in each year are given in Table 3.

Table 3

Yields of Threshed Peas given by Placed and Broadcast Fertilizer, averaging all N.A.A.S. Experiments in each Year

	AMOUNT OF FERTILIZER	YIELD (cwt. per acre)		
		Without Fertilizer	Placed Fertilizer	Broadcast Fertilizer
	cwt. per acre			
1950 2 Experiments	2.5	14.4	13.4	13.4
	5.0		—	14.0
1951 4 Experiments	2.5	14.9	18.6	16.1
	5.0		—	16.6
1952 7 Experiments	2.5	21.3	24.9	22.7
	5.0		—	22.6

It will be seen that in 1950 there were no gains in yield from any dressings. In both 1951 and 1952 there were small increases from broadcasting fertilizer and much larger increases from placing it beside the seed. Drilled fertilizer at the rate of 2.5 cwt. per acre gave much higher yields than twice as much broadcast fertilizer. To assist comparison with the Rothamsted results (Table 2), the increases in yield from the low rate of broadcast fertilizer and the gains from placement are summarized below in a similar form.

Table 4

Increase in Yield of Threshed Peas from Broadcast Fertilizer, and Comparisons of Broadcasting and Placement

	Yield without Fertilizer	Increase in Yield from Broadcast Fertilizer	Extra Yield from Placed over Broadcast Fertilizer
	cwt. per acre	*cwt. per acre*	*cwt. per acre*
1950	14.4	−1.0	Nil
1951	14.9	1.2	2.5
1952	21.3	1.4	2.2

* The Mechanical Application of Fertilizers in Field Experiments. G. W. COOKE. *Emp. J. exp. Agric.*, 1951, **19**, 160–74.

The two series of experiments have given similar results. Averaging all the experiments, approximately 2–3 cwt. per acre of phosphate-potash fertilizer placed beside the seed has given about 2 cwt. per acre more peas than the same quantity of broadcast fertilizer.

Higher Yields with Placed Fertilizer On average, there was a marked gain in yield when fertilizers containing phosphate and potash were drilled at the side of the seed. In fact, fertilizer applied in this way resulted in higher yields than were obtained with twice the amount of broadcast fertilizer. Relatively small quantities of placed fertilizer are therefore sufficient for maximum yields. In the Rothamsted experiments the average increase in yield from the single dressing of broadcast fertilizer was only about ⅓ cwt. of peas per acre ; the corresponding increase in yield from broadcasting in the N.A.A.S. experiments was about 1 cwt. At present-day prices the extra crops obtained by broadcasting fertilizer in the Rothamsted experiments were not sufficient to pay for the dressings used, and even in the N.A.A.S. experiments broadcast fertilizer barely produced an economic return. In contrast, the average increase in yield per acre from placed fertilizer was over 2 cwt. in the Rothamsted experiments, and 3 cwt. in the N.A.A.S. experiments. Such gains in yield are more than sufficient to pay for the fertilizer, and over a few seasons will justify the purchase of a special drill.

The experiments were carried out on a wide range of upland mineral soils where peas have recently become an important cash crop. The results will apply to those soils on which threshed peas respond to phosphate and potash fertilizers. On such soils, it will pay farmers to apply their fertilizer in bands beside the seed.

Need for Suitable Placement Drills There is a real need among pea growers for drills capable of placing fertilizer a little to the side and below the level of the seed. It is important that any drill marketed for this purpose should be capable of sowing the seed deeply on rough seedbeds and on heavy soils. Few suitable drills have so far been produced. Some farmers have modified combined seed and fertilizer grain drills by using every second or third coulter to sow seed, and setting another coulter close beside the seed coulter to place a band of fertilizer in the appropriate position. Where such conversions have been carried out skilfully, the drills have been very satisfactory. Other farmers have fitted their own fertilizer attachment to an existing drill (usually of the Suffolk pattern). However, few farmers have either sufficient workshop facilities or the time to build their own placement drills, and the general application of the research work described here must await the introduction of suitable commercial drills.

FARMING AGAINST RABBITS

F. D. SMITH, D.Sc.
Teddington, Beckford, Glos

After struggling for many years against rabbits coming across his land from a Cotswold escarpment, Dr. Smith eventually conquered them by fencing and systematic destruction of cover on the farm. In this article, he describes how he set about the problem.

I BEGAN my campaign against rabbits in the wrong way : I trapped them. I employed a very competent trapper who brought in the autumn crop of rabbits at the rate of about thirty a day. This paid his wages and left me a useful profit. The trapping also apparently cleared the rabbits for the time being. It was, however, only a temporary improvement, as I was to learn later to my cost.

The crux of the rabbit problem is now generally agreed to be the " hungry gap " in the dead of winter. Whereas an abundance of rabbits grazing ample summer keep is relatively unimportant, in the middle of winter even a few rabbits can do irreparable damage. Most of my rabbits came over my farm boundary from other rough hill land not under my control, and three of my fields were particularly vulnerable. I farmed these fields by the cautious method that becomes almost second nature to those farmers who suffer from the depredations of rabbits. When, however, there was an urgent national appeal for wheat, I decided to take a chance and sow one of my vulnerable fields with winter wheat. As a precaution, I engaged my trapper to trap round the field regularly right through the winter. (This was before the ban on open trapping was reimposed). The trapper did his best, but both of us had underestimated the persistence of hungry rabbits. The rabbits took so much of the wheat that the field had to be ploughed and resown in the spring. In a few weeks, the rabbits wiped out all the small profits I had made from trapping in previous seasons—and more besides.

Modern scientific farming seeks to close the hungry gap in many ways : by prolonging grazing as far as possible into the winter ; by growing winter greens ; by the early grazing of winter-proud corn ; by stimulating an early bite and thereby anticipating the spring. But all this is of no avail where land is exposed to rabbits. They graze the young corn, they nibble out young clover, they bite off young greens. I realized that I could make little use of modern technique for producing winter keep until I had protected my vulnerable fields from rabbits. I was to learn, before I succeeded in securing this protection, that perhaps the most essential factor in rabbit clearance is persistence. Rabbits have only two interests—breeding and feeding. It is little wonder that they so often defeat man in his attempts to protect his crops.

Fencing the First Step My first step for clearing rabbits off my farm was obvious—to erect rabbit wiring, particularly against the steep, rough escarpment that bounds my farm for nearly a mile. I made a mistake, however, in thinking that the first step would also be the last. The wire fence was of the conventional type ; standard rabbit wire with its bottom selvedge buried 6 inches in the ground to stop the rabbits burrowing under, and its top selvedge supported on stakes, 36 inches high, to prevent rabbits jumping over. We erected a mile of this rabbit wire through

some very rough places, and we were quite pleased when we had finished the laborious job.

In theory, a fence of this kind is rabbit-proof ; the hungry rabbits merely pad up and down on the outside of it, while fine lush crops grow up safely on the inside. In practice, it does not work out like that. My farm boundary is neither a straight line, nor does it run on level ground. It was not long before I realized that my "protected" crops were still being damaged by rabbits. I was forced to the conclusion that the rabbits were coming over the top of my wire fence. Close inspection revealed the vulnerable places ; muddy paw marks could be seen on the wire after rain, snow was dislodged from the top, tracks led up to the fence and continued beyond it ; such were the signs. Where the rabbit wire inclined a little from the exact vertical, the rabbits scrambled over it. Ant hills, fallen trees and sloping tree trunks provided them with jumping off places which gave them just sufficient advantage to enable them to surmount my fence.

It needed a great deal of persistence to counter all these activities on the part of the rabbits. As fast as I closed a weak place, they found another. The rabbits and I played Box and Cox. During the long winter nights, the fence was all theirs to surmount if they could : during the short winter days, it was all mine to make rabbit-proof if I could.

A timely fall of snow proved of great assistance to me. It revealed the rabbits' night workings with more than usual clarity. To my surprise, I found that the snow along the *outside* of my wire was comparatively untrodden, but the snow along the *inside* of my wire was beaten down into one long track. It seemed that my rabbit fence was working in reverse. It was actually increasing the number of rabbits living on my farm ! The reason was not difficult to find. A famished rabbit scenting good grazing will make determined efforts to overcome the obstacle of a wire fence, but a rabbit with its paunch well filled—a heavier, well-fed rabbit without the incentive of hunger—is not so determined to make the difficult return journey. The rabbits were settling down in new quarters on my land and sparing themselves the increasingly tiresome scramble over my fence each night.

Destroy Cover on the Farm I therefore decided that my next step must be to make my farm inhospitable to rabbits. I cleared up all those waste places and rough corners found on most farms, I cut and burnt brambles, I cleared scrub, I felled old hollow trees and cut them up for firewood. Above all, I completely destroyed all accessible burrows, both large and small, or if they were under the roots of trees, gassed them. In all this I had invaluable assistance from my dog. He showed me just where each rabbit was harbouring by hunting it until it took refuge beyond his reach. I was gratified to find that, as the work proceeded, fewer rabbits were able to escape him and, in the end, I often took him round the farm without his finding a single rewarding scent.

Complete rabbit clearance can undoubtedly be attained, as indeed it is on the best land, such as the market-garden land of the Vale of Evesham. The practical question is : when is it economic, and when is it not ? This question each farmer must decide for himself, taking into consideration soil, climate, aspect and, above all, whether his land qualifies for Government aid. Grants for hill farming and marginal land improvement assist, directly and indirectly, just the kinds of land improvement that most surely lead to control, and even to eradication, of rabbits.

A Very Profitable Improvement My own farm does not qualify for any such grants, but even so I consider the complete clearance of rabbits from my land has been one of the most profitable improvements I have carried out. Behind my protective boundary fence of rabbit wire I am now able to grow crops which previously I could not have considered ; heavy crops of winter greens on which lambs have fattened ; winter oats that have yielded 24 cwt. to the acre ; leys rich in clover where it was formerly eaten out by rabbits. Before the rabbit clearance, a chain or more along my vulnerable boundary was always grazed bare ; now I have a full crop right up to the boundary. Five chains from the boundary, the improvement is still marked ; even ten chains from the boundary, the cropping is better than it was before I put up the rabbit fence.

Above all, I can now apply ample lime and fertilizers with the knowledge that I shall reap the whole benefit and not have to share it with marauding rabbits. In the aggregate, I estimate that I have upgraded some 24 acres from rough grazing to full arable production. It has cost me about £8 an acre for rabbit clearance, and the expenditure has been recovered from better crops and grazing in about two seasons.

Many farmers will undoubtedly disagree with me in my assertion that, in trapping the rabbits, I began my campaign in the wrong way. Personally, I consider that trapping has no useful place in a scheme of rabbit clearance. Thinning down rabbits by trapping and taking a profit from the sale may be inviting but it leaves a healthy breeding stock ready to produce more rabbits for the next season. Following on my own experience, I would recommend farmers who wish to clear rabbits from their land to begin the job by clearing the scrub, felling hollow trees, digging out burrows, and cutting and burning brambles. If the trapper has not previously had the cream of the rabbits, so to speak, there is an ample sporting interest in the clearance to keep farm workers—and incidentally the farmer himself—from finding the job too dull and arduous. This is a psychological rather than a practical point, but it is of great importance for the average farmer. (Exceptionally, a *mechanical* clearance of rabbits by bulldozing bushes and burrows may well be preceded by a preliminary trapping.)

To summarize my experience, the requirements for successful rabbit clearance are : (1) destruction of burrows, hollow trees, scrub and other cover ; (2) wiring off other land that cannot be cleared, for example, cliffs, quarries ; (3) persistence and a good dog ; (4) the right approach to the rabbit problem. The last is particularly important when we consider the problem of derelict land. A farmer who thinks of rabbits as the *cause* of derelict land will attack the rabbits but will usually fail to clear them. A farmer who thinks of rabbits as a *symptom* of derelict land will turn his attention to the improvement of the land, and he is much more likely to succeed in controlling them, since he will improve his land to the point where it no longer harbours rabbits.

Above all, it must be remembered that there are two parties to every rabbit problem : the farmer on the one side, and the rabbits on the other. It does not do to underestimate the cunning and persistence of rabbits. They are by no means as stupid as they look !

OFFICIALLY APPROVED CROP PROTECTION PRODUCTS

Since the date of the list published in the October 1952 issue of AGRICULTURE (pp.346–7) the following names of proprietary products have been added to the Approved List under the Ministry's Crop Protection Products Approval Scheme.

Benzene Hexachloride Sprays :

Benzaclor Dispersible Powder	The Murphy Chemical Co. Ltd.	**AL.414**

DDT Sprays :

DeDeTane 15% Emulsion	The Murphy Chemical Co. Ltd.	**AE.450**
DDT Miscible Liquid 25% (P.P.)	Plant Protection Ltd.	**AE.452**

Sulphur Sprays :

Strawson's Colloidal Sulphur	The Strawson Chemical Co. Ltd.	**AA.469**

Organo-Mercury-Benzene Hexachloride Dry Seed Dressings :

Ceresan WS	Bayer Agriculture Ltd.	**BR.467**

MCPA (*2-methyl-4-Chlorophenoxyacetic Acid*) *Sodium Salt Dusts*

Verdone	Plant Protection Ltd.	**BH.466**

Products B.27, *B*.112, *C*.29, *E*.313, *E*.351, *G*.83, *K*.90, *O*.144, *P*.133, *R*.153, *S*.352, *AD*.215, *AE*.349, *AK*.182, *AZ*.317, *AZ*.353, *AV*.211, *BD*.354 *have been withdrawn from the list by the manufacturers.*

Applications are now invited for the official approval of proprietary thiram (TMTD) dispersible powders to be used as sprays, thiram (TMTD)-BHC dry seed dressings, BHC smokes, DDT smokes, combined DDT-BHC smokes, selective oil herbicides, organo-mercury foliage sprays. Full details of these new groups can be obtained from The Secretary, Crop Protection Products Approval Scheme, Plant Pathology Laboratory, Harpenden, Herts.

A booklet giving the list of Approved Crop Protection Products may be obtained free on application to the Ministry of Agriculture and Fisheries (Publications), 36 Chester Terrace, Regent's Park, London, N.W.1.

Ministry of Agriculture and Fisheries Plant Pathology Laboratory, Harpenden, Herts. January 1953.

FARMING AFFAIRS

60 per cent plus The growing of food is a business, just like any other commercial enterprise. Stated simply, the agents of production, land, labour and capital, are brought together in just those right proportions to ensure an adequate return for the investment made. Yet when we get down to real essentials, divesting ourselves for a moment of all trimmings, as it were, of modern civilized life, food is seen to be *the* most important commodity of all—something which is literally vital to every other enterprise to which man has turned his energy. There was a time, not so long ago either, when this basic factor in human existence was less well appreciated than it is today ; often, as far as we in this country are concerned, it was obscured by the ease with which our industrial wealth could

buy for us all the food we wanted, and the social conscience of the community generally was less well developed about other people at home and abroad who had less food than they needed for full health.

The times have changed. No one is, or should be, complacent about that today. The world population continues to increase, higher standards of life are being demanded everywhere, industrialization is spreading, and we as a nation, can no longer go with a full purse on a spending spree in the markets of the world. There is, moreover, no reason to suppose that this changed pattern of world economics is some transitory phenomenon likely to sort itself out in due course into the pre-war design. Rather is it part of the progress of civilization.

This, then, is the reason why we have just *got* to grow more food at home—the reason why a year ago the Government asked the country's farmers to increase their total production from the level of 44 per cent over the 1939 figures to at least 60 per cent over pre-war by 1956. The appeal is made to every farmer, large and small. It is a question of a little more here and a little more there ; a few more acres brought under the plough, slightly higher yields of both cash and fodder crops ; more cattle, sheep, pigs and poultry ; less waste, less loss of crops to diseases and pests of all kinds.

What can be done is in the hands of the individual farmer. True, he can get advice from his local advisory officers who are only too keen to help, and financial assistance is available to him by way of many subsidies—on fertilizers, ploughing up, calf rearing, etc. But it is on whether he takes advantage on these, whether he is content that in both acreages and yields he is farming to the full potential of his land, that the success of the campaign to win this extra food by 1956 must depend.

It is not uncommon to depict the farmer looking over the gate. Well, he doesn't spend all his time doing that, but certainly we have all known the pleasure that a good crop or a good herd gives, as seen from that coign of vantage. If we can look over the gate this year, next year, and every year afterwards and contemplate the increases which forethought has made possible, we shall feel a contentment and a sense of satisfaction in having played our part to feed what is at this moment a hungry world.

60% plus

FOOD DRIVE

Wise Stock Feeding : 1. Herbage Quality in Silage and Dried Grass

The extra fertilizers, particularly nitrogen that farmers nowadays are applying to their grass fields, together with modern methods of grazing management, provide a large excess of herbage for winter feeding. The stage of growth of the crop is, of course, the decisive factor determining quantity and quality. It is therefore important to recognize these various stages of growth and appreciate their potential feeding value so that cuts may be made at the best possible times.

Conserved grass products of very high protein content are derived from well-manured and frequently cut swards which are short and very leafy; there is an almost complete absence of stem. Herbage of this type with about 20 per cent of protein in its dry matter is usually intended, and is particularly suitable, for high yielding cows. Ideal for making into dried grass, it can also be made into good silage, although care is needed if obnoxious, underheated material is not to result. If ensiled, molasses should

always be used, and if possible the cut crop wilted to induce a good fermentation, reduce seepage and produce a high dry matter silage. Silage and dried grass of this quality are too rich in protein to be fed alone for milk production, and if valuable protein is not to be squandered they must be balanced with starchy foods. For instance, 2½ lb. of this quality dried grass contains nearly enough protein equivalent for a gallon of milk but only half the necessary starch equivalent : 2 lb. of oats could supply the other half. Rich in carotene (potential vitamin A) and low in fibre, dried grass and silage of this quality are suitable for inclusion in pig and poultry foods; their dry matter should not, however, exceed 10 per cent of the total ration.

A less rich herbage but one nevertheless adequately balanced for milk production, and when dried also valuable for pigs and poultry, is obtained when grass is cut at the leafy stage; there is some stem but no flowering-heads. The early bud stage in leguminous swards is comparable. Cutting at this stage is more common and more practical, and either as dried grass or silage it forms an excellent balanced milk production food. Some 4½-5½ lb. (depending on the precise protein content) of the dried grass or a quantity of silage containing an equivalent amount of dry matter is usually considered sufficient for a gallon of milk. Cows receiving a maintenance ration composed entirely of hay have rarely the appetite to consume sufficient silage for more than 3 gallons. As with the previous grade, wilting before ensiling will produce a more concentrated product, possibly enabling the consumption of larger amounts. When fed to fattening cattle, a quantity of this grade of silage containing 10 lb. of dry matter is enough to produce 2 lb. of flesh and supply most of the protein requirements for maintenance as well. Sheep, with their preference for short herbage, will also do well on this type of silage.

Herbage of moderate quality includes grasses which are in early flower; purely leguminous crops in full flower have a similar feeding value. This stage is usually characterized by an abundance of herbage which, rich in readily fermentable carbohydrate, is particularly suitable for making into silage. Where grass driers are used ensiling is the obvious complementary method for coping with the excess growth. The resultant silage is at its best a complete food for dairy and fattening cattle; modest yields, 3 gallons, can be achieved, and fattening bullocks can be finished on silage alone. Sufficient silage is, however, rarely available for such comprehensive feeding; more often medium quality silage is fed for part maintenance and part production. The best dried grasses in this grade can be used as milk production foods, fed at 5½ lb. for a gallon of milk. If poorer qualities are to be used for this purpose, they must be supplemented with protein-rich concentrates.

When the hay stage is reached grasses and legumes are in full flower, and with the onset of maturity nutrients are withdrawn to the roots and feeding value rapidly declines. Neither dried grass nor silage should deliberately be made from such poor quality material.

2. Unsaleable Potatoes The forthcoming new season's crop of potatoes raises the question how best to feed the old unsaleable tubers. Left-over potatoes are often sprouted, frosted, blighted or otherwise damaged, and even if not harmful, may be bitter and unpalatable. Their palatibility can be improved and digestive troubles avoided by steaming or boiling them. It is in any case essential to cook them before feeding to young stock. Whether fed cooked to pigs and poultry, or raw to cattle and sheep, 4 lb. potatoes are equivalent to 1 lb. of a cereal meal. Fed raw, they should be sliced to prevent choking, introduced gradually and fed in controlled amounts, never *ad lib.* Up to 40 lb. may be fed to fattening cattle,

20 lb. to dairy cows and 4 lb. per 100 lb. live weight to sheep. When fed to ruminants sufficient roughage must be provided in the diet to compensate for their lack of fibre. If large quantities are available, and it is neither possible nor desirable to utilize them immediately, they can be preserved for winter feeding. Unsound tubers are not suitable for clamping; they are better steamed and ensiled in a pit. The silage has a feeding value similar to that of cooked potatoes.

A useful silage can be made either by stacking whole raw potatoes and young grass in alternate layers (1 ton of potatoes to 3 tons of grass) or by ensiling a mixture of pulped raw potatoes and grass. The potatoes will be cooked during fermentation and the product is usually a pleasant and sweet smelling silage.

Colin F. Ibbotson

Farming Cameo: 29. Martley and Tenbury, Worcestershire

When Worcestershire is mentioned most people immediately think of a beautiful countryside with fruit, hops and market gardening; and this is, indeed, a faithful picture of the Martley and Tenbury districts. The Teme valley, with its deep alluvial soils growing hops down by the river and with its banks covered with fruit or woodlands, undoubtedly offers some of the most beautiful country in England.

The district comprises about 73,000 acres, of which about 40,000 acres are devoted to grass, 9,700 acres to fruit and 1,800 acres to hops. The remainder carries arable crops, the two most important being wheat (5,500 acres) and oats (4,000 acres). There are also 21,000 cattle, 11,000 pigs, 47,000 sheep and 244,000 poultry.

It is doubtful if any other district has such a wide range of soils and farming conditions. In the valleys there is some of the most fertile land that could be found, while less than a mile away is some poor Coal Measure clay which, prior to 1939, was often almost derelict but which, after heavy liming and fertilizing now grows reasonably good grass and crops.

Because of the wide variations—not only in soil but also in elevation, slope and aspect—it is impossible to generalize about the district; the only approximate generalization is that store raising predominates. The vast majority of these store cattle are Herefords or Hereford crosses. On the whole, they are well reared and command a very ready sale. Some are reared on the one cow-one-calf system, but the majority of the cows rear more than one calf, and a fair number of dropped calves are therefore brought into the area for rearing. The two main sheep breeds are Cluns and Kerrys, mostly crossed with Oxford and Hampshire Down rams.

On the Worcestershire plain of Keuper Marl, which extends into the Martley district, both dairying and corn growing are practised. Here, the land is very heavy and, in some cases, rather difficult to drain, but where drainage, cultivations, manuring, etc., are well done, excellent crops and grass can be grown. Although dairying is fairly extensive, specialist dairy farms are in the minority, mixed farming and rearing being the usual practice. Dairy Shorthorns are still popular, but British Friesians are increasing in numbers. There is an increasing tendency at present to use dairy bulls on the high-yielding cows, and to cross the others with a Hereford. Both the Shorthorns and Friesians produce excellent cross-bred calves which find a ready sale to rearing farms.

There is a small area of Bunter and Keuper sandstone where potatoes, sugar beet and market-garden produce are grown. This area, although not inherently very fertile, is very well farmed and produces excellent crops. In particular, it has established a reputation for carrot growing.

In the Teme and Severn valleys hops are widely grown, and the grassland is well known for its fattening qualities. Excellent crops of roots can be grown but fertility is so high that corn growing is almost impossible because of lodging. There is a high sheep population in this area. On certain farms because of cobalt deficiency, the lambs used to do very badly after the beginning of August, but this has been overcome by a soil dressing of 2 lb. cobalt sulphate per acre.

Fruit growing, although very important is, in many instances, at the cross-roads. A high proportion of the orchards are of mixed fruit and were planted over thirty years ago and grassed down. Many of the trees are now worn out and the grass poor because of shading, irregular grazing and scorching with spray materials. The trees, often of varieties no longer popular, are difficult to spray and pick and, with the drop in fruit prices, the produce is difficult to sell. Many owners are taking advantage of the £10 per acre grant to grub these old orchards and bring first-class land back into high production. Since the war, a considerable area has also been newly planted with apples, pears, cherries, damsons and plums. These are mostly bush trees suitable for automatic spraying and handy to pick.

J. W. Patterson,
District Advisory Officer

BOOK REVIEWS

Marginal Land in Britain. W. Ellison. Geoffrey Bles. 25s.

At a time when production from the limited acreage of Britain is being pushed to its maximum, the potential to be played by every acre has to be studied most carefully. In view of this, Professor Ellison's book *Marginal Land in Britain* will be of great interest to all concerned with food production. The necessity for producing our own food from our own land has been explained so often that it will be obvious that this new analysis of marginal land in Britain is of the greatest importance in relation to our present problems. Marginal land is rather elusive of a precise definition, but if the author's definition is accepted it is that class of land which owes its marginality to the fact that a greater input of money and effort is required for a given return than is the case on better land. It becomes immediately obvious from this definition that the problem assumes enormous proportions, and the acreage of marginal land is given as five million.

It is adequately shown in the book that development is going to be costly in terms of investment, labour and raw materials. The return that can be expected will not compare with a similar investment on more favourable areas. However, if maximum food production is to be regarded as a necessity at the present, as well as an insurance against future international happenings, then there is no doubt that the problem must be faced courageously and with speed. A nation of fifty million people cannot afford to allow a large acreage of unproductive land to remain as it is, let alone allow it to degenerate still further.

The analysis presented by Professor Ellison, takes into account both the economic and the purely technical angle of marginal land rehabilitation. In the integration of cost and technique, the book has attained success in large measure, and an attempt is made to assess the return that is to be expected from the improved areas. Much of what appears on

technique, and indeed on utilization of increased production, is well known and is already being practised by isolated farmers in particular areas. The knowledge required for tackling this problem is, then, to hand, and the raw materials necessary, in terms of lime, fertilizers and building, are within the resources of the nation.

The means, however, of putting marginal land development into practice is not clearly envisaged in the book. The stimuli that have been provided in the past have not been used fully by the marginal land farmer. Getting the work done is going to be the most difficult problem. Increased production from these areas must be bought with the minimum of waste, and it is questionable whether many of the marginal land units can be satisfactorily rehabilitated unless some change is brought about in the size and organization of the units. This all-important problem is neglected in the present work, but an answer to it must be found before we know where we stand in relation to large-scale investment in marginal land.

Anyone who is seeking a considered opinion of marginal land must certainly read Professor Ellison's book. It is pleasantly written, clearly presented and well illustrated.

R.W.W.

Green Crop Drying. R. O. WHYTE and M. L. YEO. Faber. 42s.

This book is an authoritative review of the present state of knowledge concerning problems connected with the commercial production and use of dried green crops—problems that range from methods of growing and harvesting crops for drying to the use of the dried product in rations for livestock. The last chapter, appropriately enough, presents various estimates (some of which unfortunately refer to conditions several years ago) of whether the practice is worth while from the economic point of view.

Nowadays, it hardly seems possible that so little was known about the nutritive value of young grass until Woodman at Cambridge, about 1926, established conclusively the high feeding value of the carefully dried product and first propounded the idea that grass might be grown simply as a crop for drying. *Green Crop Drying* discusses the part played by the farmer, the engineer, and the animal nutrition expert in the developments which have taken place since that time, and brings us up to date with accounts of modern crop-drying practices.

In a survey of the development of green crop drying in a number of countries, mention is made of the various kinds of co-operative drying concerns, of the large quantity of sugar beet tops dried in Germany, of the outstanding importance of lucerne as a crop for drying in the United States and Canada, and, generally, of the progress made in green crop drying in countries as far apart geographically and climatically as Sweden and South Africa.

It is perhaps a virtue in a book of this kind that the authors do not attempt to force their own opinions on the reader. They present the work, and sometimes the philosophy, of many experts, and leave it largely to the reader to assess the importance of the evidence presented.

The collection of diagrams showing the layouts of all the well-known driers in Britain, as well as many others which have been almost forgotten or are not to be found in this country, will be a useful source of reference for many years to come.

C.C.

Farm Machinery (4th Edition, revised). C. CULPIN. Crosby Lockwood. 30s.

The rapid increase in the variety of farm machines and their applications makes the task of any author who attempts to survey the whole field in a single volume one of great difficulty.

Mr. Culpin, by eliminating reference to some obsolete machines and adding a further hundred pages to the length of his book, has made a bold bid to cover his subject. A new chapter on Horticultural Machinery is included and the chapters on spraying, crop drying, and root harvesting have been completely rewritten, as have parts of other chapters, wherever advances in techniques or design require it.

Widening the scope of this book has, of necessity, resulted in very brief mention of numerous new machines and less consideration of the principles and usage of some of the essential ones as compared with the previous edition. This development is regretted, as students and farmers, for whom the book is written, will find it difficult to assess the value of particular types of machines in farming practice.

The general formula for "Rate of Working" quoted is applicable for 17½ per cent "idle time" not 20 per cent as stated, and it is regretted that the formula given for wheel slip is at variance with that adopted by the British Standards Institution and most other authors.

The quoting of trade names, whilst leading to ready identification of machines, puts a severe limitation on the author in his appraisal of the merits of the various principles employed. This is particularly the case where the design of machines has not become stereotyped and the reader needs most guidance.

This revised edition contains a great bulk of up-to-date facts on all types of machinery in use on farms, it will be of most use to those students and farmers who do not require specialized information on particular topics.

F.C.

Agricultural Arbitrations. R. C. WALMSLEY. Estates Gazette Ltd. 25s.

The use of arbitration to settle disputes has always made a strong appeal to the people of this country and especially to the agricultural community. With the growing complexity of modern farming in the business sense, the number of occasions for the use of arbitration is likely to increase. It certainly deserves to do so, for there is no better way of settling a dispute on a technical matter than with the help of a skilled, impartial and experienced arbitrator. The traditional acceptance by the parties of the findings in awards has been supported again and again by the obvious reluctance of the Courts to set them aside.

Mr. R. C. Walmsley has achieved more than his aim to assist arbitrators. To owners, farmers, land agents and students the book will make an instant appeal according to their separate interests. The subject is treated remarkably comprehensively and the agricultural code clearly distinguished from the general law on the subject. The need for hearings to be properly conducted is stressed and the judicial function of the arbitrator fully emphasized. The pitfalls which beset him are revealed, and so are the powers which are his to enforce. The author rightly draws attention to the need for a more realistic use of the arbitrator's discretion in awarding costs.

The excellent presentation of the subject deserves special mention. The book is remarkably easy to read and the matter well arranged. The examples of forms are striking in their frames and seem to gain added value from this method of reproduction.

R.G.A.L.

Sand and Water Culture Methods used in the Study of Plant Nutrition. E. J. HEWITT. Technical Communication No. 22 of the Commonwealth Bureau of Horticulture and Plantation Crops. Commonwealth Agricultural Bureaux. 42s.

Every research station concerned today with any aspect of plant nutrition, and this means in effect practically every plant biological research centre in the world, makes use at some time of sand or water culture, either for the evaluation of nutritional needs of the plant or for the growing of plants under known, controllable, nutritional conditions. This wide use of the same fundamental principle has led to an equally wide variation in methods and techniques adapted to suit the particular exigencies of any one particular investigation. Each worker has published the details of his technique separately, and any new investigator has had to search through innumerable papers to discover the several points which may apply to his own cases. There has, therefore, long been a great need, not only for the collation of these methods but, also, for their critical examination and evaluation. Dr. Hewitt has performed what may truly be called a stupendous task in compiling from all these widely scattered sources an exhaustive and critical review of every aspect of sand and water culture methods.

The book is, however, more than this ; the author extends his scope to include such subjects as methods of cultivation under sterile conditions and the control of environmental conditions for plant growth studies.

A second part gives an account of the special methods worked out by Dr. Hewitt himself at Long Ashton Research Station for large-scale pot sand culture. Complete details are provided of every aspect of this elaborate technique, which has contributed so greatly in recent years to our exact knowledge of the role of the "trace elements" and the interrelation of nutrients in plant growth.

R.H.S.

BOOK REVIEWS

The Practice and Science of Bread-Making. D. W. KENT-JONES and JOHN PRICE. Northern Publishing Co. 25s.

First published in 1934, this book has been written primarily for bakers and bakery students. Scientific knowledge and control are being increasingly used in the bread-making industry, and the authors have therefore catered for the modern baker's need for some knowledge of the materials and processes he uses.

Much information has been condensed, in this relatively small book of 264 pages ; the wide range of subjects covered includes the nature and types of wheat and flour milling, the constituents of flour, bread ingredients, chemical analysis and physical testing of flour, panary fermentation, bread-making processes and the nutritive value of bread. Such condensation, however, necessarily incurs some risk of obscuring meaning, and so confusing the reader. This occurs here in some sections : e.g., page 92 reads, " Well dressed flour of fine and even granularity is desirable and, above all, it should ripen easily in the dough and have good gas-producing properties, especially in the final proof. It is not always easy to have these conditions when flour of 85 per cent or even 80 per cent extraction has to be used." From this the student might infer that doughs made from flour of 85 per cent and 80 per cent do not gas well. In fact, such doughs gas more freely and for a longer time than those made from flour of shorter extraction.

A few mistakes have crept into the text. The reference to National flour on page 26 should read " it is not permissible specifically to exclude any germ," not " . . . all germ." On page 97, in dealing with the water absorption of flour, it is stated " . . . absorption is 15 to 16 gallons a sack but 85 per cent flour may take less." If I am correct in taking this to mean less than white flour, then the statement is wrong, as water absorption increases as the extraction is lengthened.

Apart from these few imperfections, the book should be of considerable value to the student and interesting reading to anyone wishing to know more of the practice and science of bread-making.

P.H.

Science in Agriculture (5th Edition). JOHN W. PATERSON. Longmans. 11s. 6d.

The popularity of this treatise on agriculture is vouched for by the publication of the fifth edition fourteen years after its first appearance. It first attracted attention because of the author's happy knack of condensing so much useful information into a small, readable book. This latest edition has been carefully revised—according to the publisher's note—and we open it to find 52 chapters, 30 tables and 181 text figures, including photographs, all in 293 pages.

Beginning with a statement on the atmosphere we are whirled through chapters dealing with the plant, climate, rocks, soils, manuring, water requirements, drainage, cultivation, crops, insects, animals and feeding, to mention but a few of them. This comprehensive sweep, touching on the highlights of so many facets of agriculture reduces its scientific principles to utter simplicity.

Since there appear to be no references, the reader is left unaware of the extensive information on all these subjects. However, the lack of depth in the author's treatment of his chapter headings is more than compensated by the breadth of the field of agricultural science which the book so successfully covers.

This new edition will continue to fulfil the needs of science students at secondary schools where the teaching has an agricultural bias. It is also a valuable first reader for students at farm institutes, while the undergraduate who aspires to an agricultural degree might well browse through this book, if only to learn the art of terse statement where others require reams of pages to express themselves in matters agricultural.

It is unlikely that a practical farmer would pick up this book unless his children brought it into the house.

Although there are up-to-date and well-produced photographs, there are others which would have been better left out, as for example, figure 58, which purports to illustrate the beneficial effect of using superphosphate on wheat. These detract from the general appearance of the book. On factual matters, I would question the statement about indigenous strains of perennial ryegrass on page 213 that " It is difficult to get seed of them". This may have been so in 1938 but certainly not in 1952.

Finally—and this is of much interest to students—there is the low price which makes the book remarkably good value for money.

A.G.D.

BOOK REVIEWS

Dutch Lights. "HEADLAND." Landsman's Library. 2s.

This is a useful booklet of 32 pages, and the first publication known to the reviewer devoting itself entirely to Dutch lights. Its size obviously precludes very detailed treatment of the subject, but the author, who is stated to be a well-known lecturer and adviser, has achieved considerable success in condensing a lot of useful information into a small space. He deals with the construction of Dutch lights and frames both single and double span, with systems of cropping, and general management including soil warming. The last-named is dealt with in fair detail, which may give the impression that it is practised much more widely than is yet the case, or may be warranted. Diagrams of frame construction, and cropping tables for all the main crops with times and rates of sowing, planting distances, etc., are useful features. While much of the information given is the " bread and butter " basis of Dutch light production, it is none the less valuable to the newcomer on that score, and will enable him to get a good idea of uses and potentialities of Dutch lights. Structures are dealt with only briefly, a further publication to deal with them being promised at a later date.

W.G.F.

The Essentials of Profitable Milk Production. JAMES WYLLIE. Agricultural Advisory Department. British Oil and Cake Mills Ltd. Free.

This is an excellent booklet because it makes you think. Or if you already think, you may easily have to think again. How many milk producers realize that whether to feed home-grown or purchased foods *for production* may easily depend on whether the cows are 500- or 700-galloners ? Or that a 450-gallon cow may be a profitable investment if she cannot be replaced by something better ? These are some of the problems of profitable milk production, and they are discussed with the lucidity which one expects from Mr. Wyllie.

I wish all the same that he had answered his own question : " What is meant by profit in milk production ? " For on the definition of profit depends the accuracy of his statement that the higher the average profit the greater will be the contribution to national needs. If the cost accountant's practice is followed of charging against each enterprise all the labour, paid and unpaid, spent on it, then what is best for the national larder may sometimes result in a lower profit to the producer, for the increased production may, in fact, have been achieved only by long hours of work niggardly rewarded.

Mr. Wyllie emphasizes the importance of confining the dairy stock to as small an acreage as possible when bigger profits may be gained from cash crops. But he does not, as he might have done, show that in this way practices (such as feeding comparatively expensive purchased foods instead of more cheaply produced home-grown foods) may increase the total farm profit even though they reduce the profitableness of the individual enterprise. Within the limits of 18 pages, however, it is remarkable how many interesting and important points he has touched on.

W.H.L.

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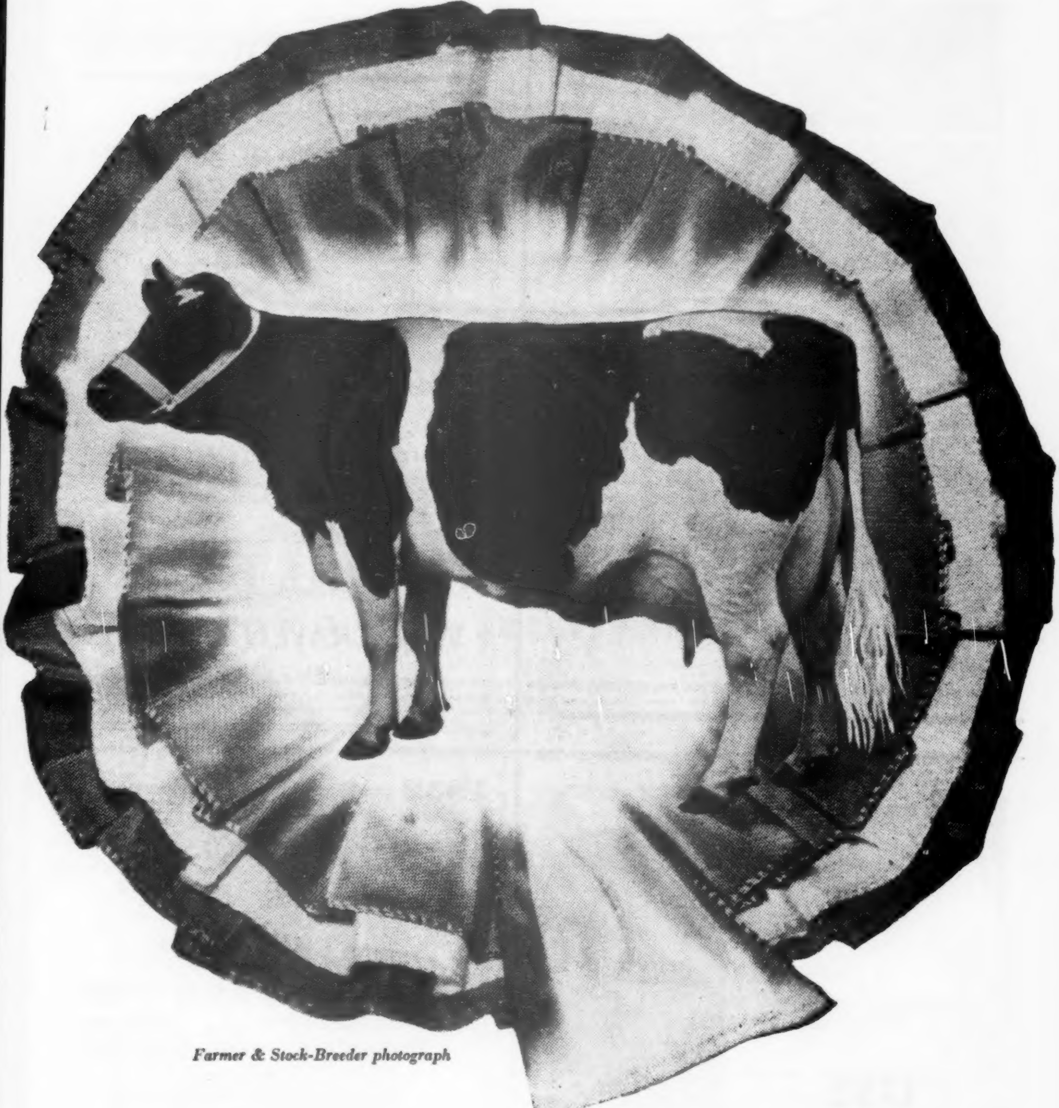

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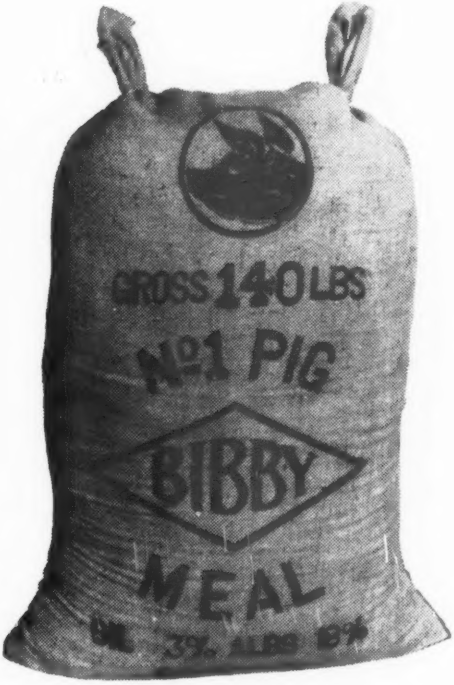

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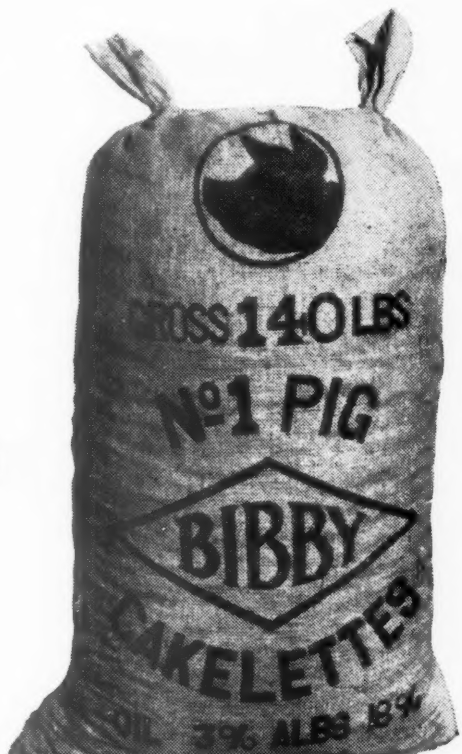

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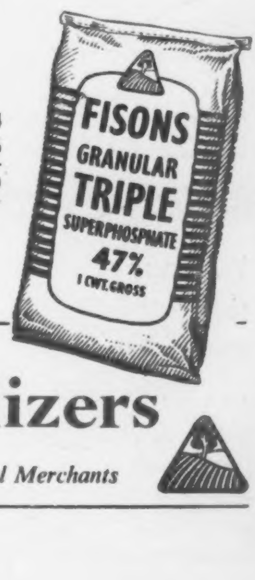

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